THE RICE WE EAT

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Compiled And Edited

By

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With a

Foreword from

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FOREWORD

Rice is one of the commonest of the foodgrains used in India, being the staple article of diet of large numbers in several parts of the country. It has, for this reason, an importance in our national economy for the cultivator, the processor, the trader and the consumer alike. Yet most of us have little knowledge of what this valuable cereal represents, literature on the subject being scanty. An attempt has been made through this publication to meet the need for information and knowledge. In the publication of the All India Village Industries Association on Rice, one of the earliest of its type, this subject was dealt with from the point of view of the revival of the handpounding industry. The revival of that industry occupied a prominent place in the programme of the Association.

It was the nutritional aspect, more than the employment aspect, that weighed with Mahatma Gandhi when he included this industry prominently in the programme of the All India Village Industries Association. Experts on nutrition had come to the conclusion which is recorded by Sir Robert McCarrison in his Primer on Rice, that, when rice is the sole or the main food of the people, it is a poor material for the building up of the bodily house, particularly if the rice consumed is not raw (as distinct from parboiled) home-pounded or unpolished. Rice is gravely deficient in body building elements if rice is milled and polished or subjected to much washing. For the bulk of the rice-eating people in India whose scanty means prevent them from supplementing their rice with other body-building foods, it is essential that the rice they consume is deprived as little as possible of the vitamin and other contents lest they fall victims

to diseases like beri-beri which, according to Sir Robert McCarrison, are otherwise common among rice-eating races.

The other standpoint that must also affect discussions on the rice processing industry, is the effect of the establishment of rice mills of various descriptions on the volume of rural employment. In 1911, the number of persons engaged in rice and flour processing industry was nearly 40 per 10,000 of the population, whereas today it is scarcely 8 per 10,000. This reduction is not offset by any corresponding increase in the numbers engaged in the rice and flour mills which provide employment for some 2 persons per 10,000 of the population as against less than half a person in 1911.

The number of hand pounders has gone down from 5 lakhs persons to 2 lakhs, while the total employed in rice mills is just over half a lakh. If the programme for the reorganisation of the hand-pounding industry drawn up by the All India Khadi and Village Industries Board had been accepted, the number of persons who would have found employment would have been 26 lakh persons. Even according to the revised plan, the numbers involved will be as large as one million persons set to work in the off-season.

These and other aspects of the hand and household industry are dealt with fairly exhaustively in the following pages. There is one aspect, however, to which, in the absence of experience and, therefore; of data, adequate reference is not made in this publication. The pattern of our social life, particularly in the matter of urbanization, has undergone such changes in the last two decades that there is poor prospect of a healthy revival of the industry unless it is organized properly from the village upwards. That organisation can assume different forms depending on the needs of the producers and the manner in which they wish to dispose of their surplus production. One can think of rural

multi-purpose cooperative societies as suitable in certain circumstances, marketing or processing societies operating in market towns in other conditions. Consumers in urban areas, if they are convinced of the superiority of handpounded rice over milled rice, can get their requirements met through contacts with cooperative societies of rural producers such as those referred to or they may buy paddy through their consumers' cooperative stores and get it pounded according to their requirements. For the success of a programme which visualizes, in the first instance, the gradual elimination of the rice hulling industry, this task of organisation is of supreme importance. The organised industry cannot otherwise be effectively displaced.

It may be that there are other gaps in the treatment of the subiect. Both the author and the Board which sponsors the publication, are anxious that any such lacunae should be brought to their notice. The labours of the author will be rewarded if his thesis is subjected to a critical study.

Vaikunth L. Mehta

EDITOR'S NOTE

The material contained in this book is not original. It is collected from various sources, compiled and edited. The object with which this has been done is to present in one volume a comprehensive picture of RICE which forms 70 per cent of the diet of 370 million people in India. For more than 50 per cent of our people, rice is the only staple food. Rice, therefore, has more than ordinary importance in the life of the people on whose health is built the wealth of the country. It is essential that, on so important an article of food, there should be adequate information.

As an article of food the use of Rice is not peculiar to India, nor is it confined to her people. It is a world-wide phenomenon. People in half the globe eat rice and it is the staple food for them. No wonder, therefore, that the quality of rice offered for consumption should receive national and international attention. No article of food has excited the curiosity of man as Rice. No other cereal has exercised the mind and intellect of men of science and of experts on nutrition problems and human metabolism, as Rice has done.

Considerable attention has been directed during the last 100 years towards determining the properties of Rice, how it is processed, what effect the different types of processing have on the grain and how processed rice fits in with the diet of the people who are mainly dependent on it. What is aimed in this book is to bring these different aspects as they have emerged after scientific, sociological and nutritional inquiries and experiments and studies on deficiency deseases to public focus. The object sought to be served is to bring information to the common people

in as simple a form as possible and to assist those who are engaged in nutritional guidance work.

It is not claimed that this book provides an exhaustive treatment of Rice or the problem of Rice. So much has been written on the subject in recent times, particularly on the subject of processing of Rice and the relative value of hand-pounded rice, under-polished rice and milled polished rice. Much has also been written on the impregnation of vitamins into polished milled rice, otherwise known as "Rice Enrichment". This aspect of the problem of Rice has great significance to India.

The All India Khadi and Village Industries Board advocates the return to the consumption of hand-pounded rice and promotes the revival, reorganisation and rehabilitation of the Hand-pounding of rice industry. It has, consequently, recommended to the Government of India, the gradual elimination of all rice mills, big and small. It is our view that they are a menance to national health. This view has been accepted by the Rice Milling Committee which was appointed by the Government of India (Ministry of Commerce and Industry). Evidence of the superior qualities of Hand-Pounded Rice is available from reports of international bodies, research institutes and workers, and nutritional studies which have examined the problems of rice.

In the preparation of this book I have drawn copiously from a number of publications and reports. A Bibliography of the more important of these publications is given at the end of this book. As has already been stated at the beginning of this Note, what I have done is to collect the varied material found in these publications and to compile, collate and edit that material. I must express my gratitude to Sri Viswanath Thekumala, Research Officer in the Department of Economic Research of the Board, for going through the manuscript and for valuable advice regarding the arrangement of the matter. The labour that has gone into the preparation of the book, is a labour of love. I shall

feel fully rewarded, if those who happen to read this book find in it a full picture of Rice and the problems related to the consumption, are persuaded to return to the consumption of hand-pounded rice and to assist in the promotion and propagation of its use.

C. K. Narayanswami

CHAPTER I

CULTIVATION OF RICE

1

Habitat of Rice

Rice (Oryza Sativa) is the principal food crop in the plains in the tropical and sub–tropical parts of South-eastern Asia and one of the oldest cultivated food grains. It thrives best in high temperatures and abundant moisture and is generally grown in fields susceptible of being flooded at certain stages of its growth. Hence, the largest areas under rice are located in river deltas or low–lying coastal districts or in tracts subject to inundation during the rains. Provided the water supply is abundant and the summer sufficiently warm, rice may also be grown in hill tracts at high elevations, as for example, in Kashmir, where compartively large areas are put under this crop in wide, gently sloping valleys of the river Jhelum at an average height of some 5,000 feet. Rice culture is also carried on on the Kangra Valley of the Punjab and along many of the lower slopes of the Himalayas in Uttar Pradesh, Bihar and West Bengal. For the purposes of cultivation, the hill sides are cut into terraces which are levelled off and embanked by means of dams in order to retain the moisture obtained from streams or from rainfall.

Oryzoe, the genus to which cultivated varieties of rice belong, consists of 23 species of which 21 are wild and 2 cultivated. All the cultivated varieties grown in Asia, America and Europe belong to species O. Sativa and O. Spontanea, while those cultivated in West Africa belong to the species O. Glaboerrima. O. Sativa is considered to be a native of India and Indo–China,

but has spread to all rice growing areas of the tropics and the sub-tropics, classified into two distinct races O. *Sativa-var indica* and O. *Sativa-var japonica*. The former comprises all the cultivated varieties of India, Indo-China, Philippines, Southern China, etc., while the latter is confined to northern sub-trophical regions of Japan, Korea and Northern China from where it has also spread to U. S. A., Spain and Italy. It has been discovered that more than 8,000 botanically different varieties are in existence in the world to-day, of which more than 4,000 have been indentified in India.

It is impossible to state, even approximately, when the cultivation of rice first assumed importance in India; but it may be noted that the first mention of rice occurs only in the last of Vedic literature—the Atharava Veda—1800-1000 B. C., while barley and other food grains were mentioned in earlier works. Indeed barley appears to have been the first cultivated grain in India although, in its wild form, rice must have formed part of the inhabitants of the eastern and southern parts of the country from very remote times. The time-honoured religious customs, obtaining in many parts of India, which entail the use of rice in the form of offerings, are also an indication of the antiquity of this cereal.

2

Soil and Rice

Little scientific work has been done on the effect of soil conditions on the nutritive value of rice. It was reported that rice grown on good soil contained higher percentages of soluble carbohydrates than rice grown on poor soils, whereas the latter contained considerably more ash. The following observations

may be of interest :

1. Rice grown on alkaline soil which contained silica, absorbed unusually large amounts of silica.
2. When the soil was high in soluble iron which was largely in ferrous state, the iron content of both heads and straw was also high.

The following experiments indicated that the chemical compostion of the garin can be influenced by fertilisers :

1. The addition of nitrogen to a deflocculated silt loam soil increased the percentage of protein in the rice and the yield of rice.
2. The application of phosphorus to a soil deficient in this nutrient, resulted in greater yield of rice and a higher phosphorus content on a percentage basis.

It has also been recorded that the cystine, tryptophane, lysine, arginine, and histidine content of rice can be increased by the use of fertilizers.

The following effect of irrigation in the nutritive value of rice has also been reported: "Rice grown on puddled fields, in which a layer of water is always allowed to remain, has a nutritive value approximately one-third less than the same rice when grown under dry rain-fed conditions. The lower nutritive value of rice grown under wet conditions is due, in part at least, to its lower content of water-soluble vitamins. These conclusions are based upon chemical analysis as well as rat-growth experiment."

There is thus some evidence that the nutrient content of rice is influenced by variety, the kind of soil in which rice is grown, and by the application of fertilizers. The importance of variation in nutritive value due to these factors should not, however, be over-emphasised, since it is outweighed by the effect of processses to which rice is subjected after it has been harvested. This point is clearly expressed in the following statement :

" There are differences in nutritive values of different kinds of rice, and of the same rice grown under different conditions; but such variations of food value are of secondary importance in comparison with what can be attained by measures directed towards the conservation of the food value of the rice ordinarily produced. "

3

Area and Yield

In point of acreage, rice is by far the largest single crop grown in India. The average annual area under this cereal in India was 58.7 million acres in the three pre-war years, 60.3 million acres during the war period, 64.5 million acres in the three years ending 1948-49 and 75.95 million acres in 1954–55. A progressive increase in acreage is thus indicated. The crop is grown mostly in Madras, Bihar, West Bengal, Madhya Pradesh, Uttar Pradesh, Orissa and Assam. After partition, the the largest rice-growing areas are Madras, West Bengal and Bihar. Madhya Pradesh, with its merged areas, claims as much as Uttar Pradesh, namely, 12. 1 per cent of the total Indian paddy area. The average annual production of rice in India came to a little over 21 million tons during the per-war triennium, 1936-37 to 1938-39 and to over 20 million tons during the war period. Production during the post-war 3 years ending 1948-49, however, reached the pre-war level. Madras claimed 21.3 per cent of the production, West Bengal, over 16 per cent, while Bihar's share was just over 12 per cent in the post-war period. Rice production in 1954-55 was a little over 24.5 million tons*.

The yield per acre of rice depends on a number of factors, e.g., rainfall, irrigation, soil and the variety of paddy grown. It is

*Agricultural Situation in India, May 1956.

particularly important to note that transplanted rice normally gives a higher yield than when the crop is sown broadcast. The yield per acre in India doės not compare very unfavourably, on the whole, with that of certain other countries in South-eastern Asia, and falls far short of the yield in the Mediterranean countries, the United States and Japan. A decline in rice yields, in comparison to pre-war years, has been a world phenomenon. The increase in rice acreage has not succeeded in effectively increasing rice production in India. Though the area under rice has increased, in recent years, by 3.8 per cent, the increase in yield has been only 0.4 per cent.

In most parts of India there are three rice crops in the year, viz; the Aus (Autumn), Aman (Winter) and Boro or Dalua (Summer), according to the season in which they are harvested.

CHAPTER II

VARIETIES OF RICE

1

Structure of the Grain

The paddy consists of an outer shell or husk which has no food value and constitutes, on an average, about 23 to 25 per cent of the whole grain. This has to be removed before the rice is processed for food. The kernel itself has a thin outer seed coat or bran layer technically called pericarp, then follows the aleurone layer which is rich in nutrients. The embryo or the germ is situated at the base of the kernel. The pericarp layer contains some nutrients, but most of the vitamins, proteins, fats and minerals are concentrated in the aleurone layer and the embryo which form about $1\frac{1}{2}$ to 2 per cent of the grain weight. The next is the endosperm which forms the major part of the rice kernel (74–75 pre cent) and mostly consists of starch.

The main object of milling is to remove the outer shell or the husk and a part of the pericarp layer which is indigestible. But actually, in the process of milling, the two layers, viz., the pericarp and the aleurone layer, are removed and the embryo is also knocked out. The greater the amount of polishing, the greater is the loss of these constituents which are rich in valuable nutrients. In order, therefore, to preserve the nutrient value of rice which is the only source of sustenance to vast numbers of the people in India, handpounding is being promoted, or rather revived. Handpounded rice retains most of these nutrients and thus makes a more wholesome healthy food. It has also been found that bold or coarse varieties have thicker aleurone layer and more nutritious than the fine varieties.

In the simplest indigenous method of husking, the paddy is placed in a wooden mortar and pounded by means of a wooden pestle worked by hand or by foot. This cracks the husk inclosing the rice grain and removes much of the inner skin and the embryo. Some of the starchy grain is also powdered in the process. improved methods of hand-pounding now protects the pericarp, aleurone layer and the germ and thus preserve all the vital nutrients in the rice kernel. Separation of the whole and broken rice from the husk and dust is carried out by winnowing.

2

Physical Qualities of Rice

In determining the quality of rice, particularly in respect of requirements of consumers and for cooking purposes, the most important factors are the size and shape of the grain. Other things being equal, fineness or slenderness is indicated by a fairly high length to breadth ratio and small size and these, singly or in combination, are the two main physical characteristics which place rice high in the quality range. In accordance with the criteria of size and shape of grain, rice in India may be devided into the three categories of fine, medium and bold (or coarse) rice.

From the marketing point of view, it is necessary to note the highly localised nature of the market for certain types of rice. The degree of importance attached to each quality factor varies widely in different parts of the country. For instance a long slender, fragrant rice, such as the highly priced *Basmati* grown in Uttar Pradesh and the Punjab would not be appreciated by the main body of consumers in South India, while parboiled, hand-pounded rice of yellow or reddish colour, popular in West Bengal, Orissa or Bihar, would hardly be considered fit for edible purposes

by the people in other parts of Northern India. Natural translucency (which is not the same as the translucency imparted by parboiling) is, however, almost everywhere accepted as desirable. As a rule, the whiter the colour, the better the quality and the higher the price of the product. Natural fragrance or aroma is also a much valued quality particularly if the fragrance persists after the rice has been cooked. Other qualities, which are looked for are uniformity of size and shape, age or maturity and freedom from impurity or foreign matter.

3

Varieties And Trade Names

The innumerable trade names and synonyms given to different types and varieties of rice are generally derived from some outstanding physical attributes either of paddy or of rice itself. The rice may also bear the name of the locality where it is grown, the centre in which it is assembled and milled or whence it is distributed. It is also interesting to note that some of the finer and more expensive types may frequently be named after the characters in Hindu mythology or may derive their names from Hindu divinities. The citation of a few typical examples of derivations will suffice. *Basmati*, the name of the well-known fine scented rice of Northern India, is derived from "bas" meaning smell or savour and '*mati*' the Sanskrit word for mind or sence. *Dilpasand* is literally "heart's delight" and is the name given to a medium variety grown in Madhya pradesh. "*Hansraj*" a fine rice grown in the Punjab and Uttar Pradesh derives its name from "*hans*" swan and "'*raj*' king—king of swans— signifying a bright white colour. *Samundrasok*, a medium rice, grown in the Madhya Pradesh, means "sea foam" from "*samundra*", the sea. *Hiranaki*, a fine, translucent small-grained rice, also of Madhya Pradesh, is a compound of "*hira*" diamond and either "*naq*" meaning pure, exquisite, or "*nak*" meaning conspicous, all indicating clearly the

physical appearance of this rice. Other descriptive trade names, taken at random, are *Tehri* or *Tedi* meaning bent or crooked and *Tulsi Amrit* signifying elixir of *tulsi* (a sacred plant), the former a medinum variety of rice with a curved grain and the latter a handpounded high grade product, both grown in the Seoni district of Madhya Pradesh. *Radhamallam* is another fine rice of Madhya Pradesh meaning "dear to the goddess Radha". Seeta, derived from the Hindu goddess Seeta, denotes the well-known export rice of Bengal prepared by hand-pounding patnai paddy. *Dudhkalma* and *Jatakalma* are two popular varieties of Bengal known generally by the abbreviated name Kalma. The former has a slightly white colour and is, on that account, given the prefix "dudh" milk. The latter is produced from an awned paddy carrying tufty ears and is descriptively termed "*Jatakalma*", "Jata" meaning a tuft of hair. A very common general name for nondescript inferior varieties is "mota" meaning fat or plump. The term is indiscriminately applied to a wide range of different types of rice, raw or parboiled, milled or hand-pounded.

Examples of rice carrying place names are *Saharanpur Sela* and *Burdwan Sela*. These well-known trade descriptions are given to parboiled rice produced in or near the towns and districts of those names, Saharanpur being in Uttar Pradesh and Burdwan in West Bengal. *Delhibhog* and *Dillichawal* (Delhi rice) are names given to the *Basmatis* produced around Saharanpur and Dehra Dun partly owing to the fact that Delhi formerly used to be a large distributing centre for these varieties and partly because Delhi is the best known place name within a reasonable distance of Saharanpur and Dehra Dun. On the other hand, it might be assumed that *Nellore Samba* signified a rice grown in or near the Nellore district in Madras, but this is not so as the name is given to a parboiled variety indegenous to the districts of Tanjore and Tiruchirapalli, a considerable distance from Nellore. *Ambemoly* and *Jirasal* are popular varieties in Gujarat and Maharashtra and are considered to be superior varieties.

CHAPTER III

CONSUMPTION OF RICE

1

Rice for the Table

Rice is the most important single article of food in India and more than 90 per cent of its production is consumed in various cooked woprations, the great bulk being taken in the form of plain boiled rice. The per capita consumption of rice estimated at about 181 lbs. for undivided India in the pre-war period, has fallen to 137 lbs. for India in the post-war period. Per capita consumption varies in different areas of India from about 14 lbs. in the Punjab to 432 in Assam.

Throughout the main rice producing areas, West Bengal, Bihar, Orissa and Assam, in many districts of Madras, in the dense rice areas of Uttar Pradesh and Madhya Pradesh and in scattered parts of Bombay, rice constitutes the staple food of the great majority of the rural population throughout the year. A very large proportion of town dwellers in the areas mentioned above also uses rice as staple diet. In other parts of India, the consumption of rice is seasonal.

Of the three varieties of rice, fine, medium and bold (or coarse), fine rice is the costliest. Raw, fine rice, newly harvested or only a few months old, does not cook so well as older and more mature–varieties and, therefore, fine rice which has been stored for a year or more, commands a premium. Medium rice is normally the most important commercially. Bold (or coarse) rice is usually consumed by cultivators, artisans and manual workers.

Rice is prepared for the table in a number of ways of which by far the commonest and the most important is to boil it in water. The grains are usually first washed in two or more change of cold water and then put on to boil. The amount of water used for boiling varies according to personal taste and local custom. In South India, for example, much more water is used than the rice can absorb. The excess of water, after the rice has been fully cooked, is decanted and generally thrown away although, in some cultivators' homes, the *kanji*, as it is called, is given to cattle as drink. In many parts of North India, rice is boiled in just about as much water as it can absorb.

The rice prepared in the above manner may be taken along with curry, cooked pulses, butter-milk or with milk and sugar.

A favourite dish in Nothern India, particularly, during the winter months is *khichdi*, literally a "mixture" which is prepared by boiling together rice and lentils or other pulses, and seasoned with salt to taste.

Kheer another well-known preparation, considered something of a delicacy, is made by boiling rice in water and/or milk with the addition of sugar to taste. Muslims, for example, generally prepare it on thé eleventh day of every lunar month, as this day is regarded auspicious. Among the Hindus, *Kheer* is eaten during certain ceremonies preceding the Dusehra festival in the Autumn. *Firini* is a somewhat similar product and differs from *Kheer* only in that, ground rice is used in its preparation.

Pulao, a dish known the world over as *Pillau* or *Pilaf*, and *zarda* are other favourites, particularly among the muslim community. Pulao is a rich preparation of rice cooked in ghee (clarified butter) usually with mutton, with or without vegetables of which peas are the most popular. Spices, such as cardamom, cinnamon and sometimes, a pulao may contain a sprinkling of almonds and cloves and raisins are often

added. *Zarda*, on the other hand, is a sweet dish prepared with ghee and sugar and coloured yellow with saffron. Where no colouring matter is used, the preparation is known as *sufeda* (white).

Rice chapatis are thin unleavened cakes made of rice flour, ground from *Bold* or *Coarse*, soft-textured rice or from brokens. The consumption of rice in this form is fairly common in many parts of the Rohilkhand division of Uttar Pradesh.

In addition to the above-mentioned preparations, there are a number of others peculiar to South India. Some of these are *puttu, dosai, iddli, uppuma, sojji, appam.*

2

Rice Products

The three principal rice products of any comercial importance in India are (i) parched rice (murmura) (ii) beaten rice (chura) and (iii) parched paddy kheel. Reliable data regarding quantities of rice and paddy utilised in manufacturing these are not available. The total quantity of rice thus utilised, however, was estimated in the per-war period to amount to about 4 per cent of the average total supplies of rice available to the country.

Although the production is relatively small, the quantity of rice processed into the three products in nevertheless considerable and provides employment for a large community known generally as bharbhunjas, as a cottage industry the extent of which may be gauged from the fact that the census of 1931 showed the number of persons engaged in this occupation as 1,00,872 men and 1,54,926 women making a total of 2,55,798. It should be noted that whereas a considerable proportion of the bharbhunja community is also interested in the parching of other cereals and pulses, the majority handles rice, particularly in those areas in which rice is the most important crop.

The total quantity of paddy (or rice) used in the manufacture of parched paddy, parched rice and beaten rice does not yield an equivalent quantity of products. Certain losses inevitably take place, for instance, in the natural moisture of the grain which is driven off by the parching process, a treatment in which great heat is applied. Some of the grains also fail to expand sufficiently and are winnowed out when the product is being finally dressed over before being put up for sale.

Enquiries made at parching establishments have made a fair estimate of the actual recovery of parched products and beaten rice from a given quantity of raw material possible. The proportions vary according to the type of rice used, the treatment given and the amount of winnowing or dressing to which the finished product is subjected.

When parched rice is being made direct from parboiled rice (not from paddy), an outturn of between 85 and 90 per cent may be normally expected. From areas as far apart as West Bengal, Delhi and Baroda, the percentage of recovery was 87.5 per cent. When the parched rice is prepared from paddy, the net recovery, based on conditions in major States, averaged about 60 per cent. This tallied closely with the net recovery of parched rice prepared directly from parboiled rice, the outturn of the former calculated on the equivalent of paddy working out to roughly 59 per cent. Variations were observed in the percentage recovery of parched rice from 47.5 per cent in Uttar Pradesh to 73.7 per cent in Bombay. In the majority of instances 55 and 61 per cent were the normal limits.

The average recovery of parched rice from paddy was 61 per cent, with a range of 50 per cent in Uttar Pradesh to 67.5 per cent in Bihar and Orissa.

Beaten rice showed an average outturn of 64.5 per cent, the outturn being least in Travancore, where it was given as 56.3 per cent and greatest in Baroda were the proportion was 66.7 per cent.

3

Production

The quantity of rice products manufactured in the various States differs considerably and depends to a large extent on local demand. No data are available. The volume of trade in parched paddy is not large—probably not more than 10 per cent of the total production. Beaten rice, however, has a more important position from the marketing view point than either of the other two kinds of preparations. This is due to its keeping quality and can be preserved for months without deterioration. The quantity of parched paddy manufactured is much smaller than that of parched rice and beaten rice.

As estimate of the total Indian production of parched products and beaten rice and the share of the major States in the pre-war period, shows that Bengal was the largest producer of both parched rice and parched paddy, altogether 8 per cent of the average crop of Bengal being used for conversion into the various products. Bengal accounted for almost 50 per cent of the total quantity of rice converted into parched products and beaten rice in undivided India. The next area in which the parching industry is of importance is Uttar Pradesh, where some 12.5 per cent of the total crop, was thus utilized. Ranking third are the States of Bihar and Orissa where 3 per cent jointly of the crop was estimated to be used for manufacturing these products. In other States, the parching industry is not of much importance. Madras, with the largest production of rice in India, used normally only 0.7 per cent of the local crop to convert into rice products. In Bombay, the proportion was 2.6 per cent made almost exclusively into parched and beaten rice, the production of parched paddy being negligible. The only other State in which rice products are of any importance quantitatively is Madhya Pradesh. The products most in demand here are parched and beaten rice. Although Asssam's rice crop

is relatively large and the local inhabitants are predominantly rice eaters, only 0.5 per cent used to be converted into beaten rice, there being no manufacture of parched rice and parched paddy. A certain amont of the latter is normally imported from the adjacent State of West Bengal.

Methods of Manufacture

These rice products are prepared as a cottage industry. As a rule, they are prepared by persons who specialise in this work and whose calling is more or less hereditary. They are widely known as bharbhunjas.

ParchedRice (*murmura*) : Although parched rice is produced in almost every tract in which rice is grown or consumed in any quantity, this product varies a good deal more in appearance and taste than parched paddy and beaten rice owing to the different methods of manufacture. In all cases, however, the kernel of the finished product is distended and crisp. Colour may vary from a greyish to a brilliant white and the product may either be salted or unsalted. Well distended grain and very white kernels are most appreciated and fetch the best prices. Parboiled rice is always preferred, experience having shown that this type gives the best results. There is, however, no standard criterion of quality. Each parcher has his own ideas as to the kind of rice best suited for treatment.

The parching operation is a simple one. Sand, which has previously been heated to a high temperature, is poured into an iron pan which is stood over a fire. Three or four handfuls of rice, or more, depending on the size of the roasting utensil, are thrown into the pan* and rapidly stirred into the hot sand with a long metal ladle or strong clean fresh broom. As soon as the rice begins to crackle and swell, the contents of the pan are run off

*An open earthen vessel may also be used.

and the mixture of sand and parched rice passed through a sieve in order to separate them. The sand is again heated and the process repeated.

Two or three variations in the above process are adopted in West Bengal, Bihar, Orissa and Madhya Pradesh. In West Bengal the rice is first fried in an iron pan with frequent sprinking of salt water. It is then removed and parched in hot sand. In Bihar and Orissa a kind of parched rice, known as bhunja, is made from unsalted parboiled rice in the same way as the parched rice of West Bengal. The name *murhi* is, however, given in Bihar and Orissa to a product made from paddy by a different process. The paddy is soaked in water for two or three days. It is then boiled for one to two hours and is followed up by drying (in the sun), dehusking (by pestle and mortar), salting, frying and finally parching in hot sand in the usual way. In Madhya Pradesh, parched rice is made directly from rice which has been previously steeped for several hours in a dilute salt solution. It is dried and parched in hot sand.

Ground Parched Rice (Sattu): After parched rice has been made it is winnowed or sieven and the small insufficiently expanded kernels which have no saleable value are set apart for grinding into flour by means of the hand *Chakki*. This product is known in Northern India as *Sattu*, and is in some demand, specially in the hot summer months.

Parched Paddy (Kheel): The following is a typical method of preparing parched paddy. The grain (paddy) is first dried in the sun for a period which varies according to the season. In winter, for instance, full 8 to 12 hours may be necessary, but in the summer 4 hours may suffice. In the evening the dried paddy is filled into large earthen jars. Hot water is then poured into the jars and after two or three minutes the water is emptied out. These jars are now inverted and kept in that position throughout

the night. In the morning the moist paddy is taken out and exposed to the sun for a short period. While it is still moist, it is kneaded and, at the conclusion of this operation, parching is carried on exactly as has already been described in the previous paragraph. During this process, a fair proportion of the kernels expand and burst and turn into soft white grains. After parching has been completed the sand and the grains are separated through a sieve and the product is subsequently winnowed in order to remove the husk. The resultant products of this treatment are (i) *kheel* (burst soft white kernels), (ii) *thuddi* (unburst hard parched kernels) and (iii) husk and foreign matter. *Thuddis* are manufactured into *murmuras* (parched rice of inferior quality).

Beaten Rice (Chura) : The most desirable quality characteristics of beaten rice are that it should be thin and papery and of white colour. The flakes should also be as large and broad as possible and there should be minimum of small or broken flakes. Beaten rice is, generally, prepared in the following manner from paddy and never directly from rice :

The paddy is steeped in water for two or three days to soften the kernel. It is then boiled for a few minutes and taken off the fire. When the water in which the grain has been boiled has cooled, it is drained off. The paddy is now placed in shallow concave earthen-ware vessel or iron pan and kept over a strong fire until the husk bursts open. The next operation consists of pounding the grain generally by means of a wooden pestle. This flattens the rice kernel and removes the husk. The latter is finally separated by winnowing in the usual way in a tray (*supa*). The procedure in Uttar Pradesh is slightly different in that paddy is directly fried after soaking and without having been boiled.

CHAPTER IV

RICE AND HEALTH

1

Chemical Composition of Rice

In 'Health Bulletin No. 23' (1938) the following analyses of rice are given :

	Moisture per cent	Protein per cent	Fat (ether extractives) per cent	Calcium per cent	Phos-phorus per cent	Calorific value per 100 C
Raw home-pounded	12.6	8.5	0.6	0.01	0.17	350
Raw milled	12.6	6.9	0.4	0.01	0.11	350
Parboiled home-pounded	13.0	8.5	0.6	0.01	0.28	350
Parboiled milled	13.3	6.4	0.4	0.01	0.15	350

These may be regarded as typical values for raw and parboiled rice, homepounded and machine-milled. Ordinary samples of rice contain from 10 to 14 per cent moisture; minor variations are of no significance. Rice contains very little fat — less than 2.0 per cent. Variations in the fat content of different samples, or losses due to the milling process, are probably not of great significance in nutrition.

The protein content of both raw and parboiled rice is reduced by milling. If any series of different botanical varieties is taken, the mean protein content will be higher if the rices are home-pounded or under-milled than if they are machine-milled.

Variations in content of protein and other food factors between different varieties in the same milling state need consideration. No two samples of rice give precisely the same analysis. It is, therefore, important to know the range of variation to be expected. If the usual range is small, then figures representing the composition of various ordinary kinds of rice may be used for practical nutrition work without leading to serious error. If, on the other hand, individual varieties show striking differences in their content of protein minerals, etc., it might be necessary, in carrying out diet surveys or preserving institutional diets, to give weight to the variety of rice used.

Protein

A number of analyses of rice varieties which include determinations of protein content, has been carried out by workers in India. Data obtained by McCarrison and Norris (1924), Basu and Sarkar (1953), Sadasivan and Srinivasan (1938), together with unpublished results from the Coonoor Laboratories, are summarised below. Basu and Sarkar studied Bengal varieties, the remaining workers, South Indian varieties.

Mean protein content of rices treated in various ways.

	Husked or Home-pounded		Machine-milled	
	Raw	Parboiled	Raw	Parboiled
Number of analyses	50	40	59	32
Mean protein content (grammes per cent)	7.1	7.2	6.2	6.1
Number of samples lying outside 20 per cent of mean value	5	3	9	2

The Table shows that protein content is little affected by parboiling, but reduced by 15 per cent on the average by machinemilling.

The biological value of the proteins of Indian rices has been studied by Basu and Basak (1937) and extensively by Swaminathan (1937,1938) using rats. These workers recorded high values in agreement with results obtained by workers in other countries. Basu and Basak (1939) have found that the average biological value of the mixed proteins of a diet composed of rice, pulse, and vegetables was 75. When wheat was substituted for rice, the value fell to 66. These values were obtained from experiments on two human subjects. About 80 per cent of the protein in the experimental diets was provided by the cereal.

Rice is the main source of protein in the poor-rice-eater's diet. While an increase in the protein content of typical rice diets is desirable, there is little evidence that protein deficiency is among the more important faults of such diets. No specific pathological conditions in rice-eaters, ascribable to protein deficiency, have been reported.

Phosphorus

The Table below shows the average phosphorus content of raw, homepounded, parboiled home-pounded, raw milled, and parboiled milled rices. The phosphorus content of the milled rices is on the average 50 per cent of that of the husked or home-pounded samples. In each group the range of variation is very considerable. The phosphorus content of rice is largely determined by the amount of pericarp present.

	Husked or Home-pounded		Machine-milled	
	Raw	Parboiled	Raw	Parboiled
Number of samples	42	31	51	32
Mean phosphorus content (grammes per cent)	0.28	0.26	0.13	0.14
Number of samples lying outside 50 per cent of mean value	5	1	5	2

The mean values for raw, milled and parboiled milled rice given in the Table show little difference. For the purpose of this analysis phosphorus content of 5 varieties of rice, both raw and parboiled, milled to approximately the same degree, was determined. The quantities of phosphorus present in the raw and parboiled samples were 0.09 g. and 0.12 g. per cent respectively, i. e., 25 per cent less in the raw rices. The effect of different degrees of milling on the phosphorus content of two varieties of rice, both raw and parboiled, has also been studied. The samples were milled by a small hand-machine. The results show that the phosphorus content falls as milling proceeds. In very highly-milled samples from which as much as 20 per cent of millings has been removed, only 12 to 30 per cent of the phosphorus initially present remained. The loss on milling was but little reduced by previous parboiling. This finding is in agreement with that of Subramanyan, Srinivasan and Das Gupta (1938).

Calcium

The calcium content of a number varieties of rice grown in India, both raw and parboiled, in various stages of milling, have been found to be very low in calcium content, as may be seen from the following Table :

The Calcium content of Indian rices
(G. per 100 G.)

	Indian rices	Number of analyses	Average value	Maximum value
McCarrison and Norris (1924)	South Indian varieties	16	0.013	0.019
	Bengal Aus varieties :			
	Raw husked	5	0.015	0.018
	Raw milled	5	0.012	0.018
	Parboiled husked	5	0.013	0.016
Basu and Sarkar (1936)				
	Bengal Aman varieties :			
	Raw husked	5	0.043	0.051
	Raw milled	5	0.013	0.016
	Parboiled husked	5	0.043	0.051
Sadasivan & Srinivasan : (1938)	South Indian varieties :			
	Raw unpolished	22	0.050	0.064
	Parboiled unpolished	22	0.021	0.043
Coonoor Laboratories	South Indian varieties :			
	Raw home-pounded	5	0.005	0.008
	Parboiled home-pounded	5	0.006	0.011
	Raw milled	5	0.004	0.005
	Parboiled milled	5	0.003	0.005

Rice is a poor source of calcium, whatever the variety or the state of milling. The poor rice-eater, consuming 600 g. of rice daily, obtains only .03 g. to 0.06 g. of calcium from this source. As a rule the supplementary foods he consume provide only small amounts of calcium and the total amount in typical diets lies between 0.15 g. and 0.30 g. daily. This is considerably bellow physiological standards.

Iron

Rice usually contains 1 to 3 milligrams of iron per 100 grammes. It is not, compared with other cereals and most common food stuffs, rich in this element. Milled rice is poorer in iron than home-pounded rice.

2

Food Value Of Rice

The function of food is threefold:

1. to supply the substances that make the body grow and repair the tissues as they get worn with use: these are called proteins;

2. to provide the energy for the various functions of the body: the heart to beat, the lungs to breathe, the muscles to move, the stomach to act on the foods: this energy is supplied by fats and carbohydrates;

3. to maintain the human system in healthy working order: for this mineral salts and vitamins are required. Almost any kind of food can supply energy, but for growth and maintenance of a healthy condition of the body, some foods are better than others.

The rice contains, besides starch, protein, iron, calcium, phosphorus, fat and vitamins A and B. If it is pounded by hand

the quantity of protein, phosphorus and vitamin B present in it is sufficient for the body's requirements. For an adequate supply of the other constituents, however, the rice eater must look to other articles of food.

Nutrients in Rice

The total protein content of rice is lower than that of most varieties of wheat and also than that of whole corn. But rice protein is of good quality. The proteins of white (millied) rice compare favourably in amino-acid content with whole wheat and whole corn proteins. Judged by the "protein efficiency ratio", biological value, and net utilization figures, the latter are inferior to rice proteins which have also been found to be superior to those of corn and oats in experiments with rats and which gave a biological value of 86 for rice proteins at a 5 per cent level of protein intake. A biological value of 80 for the proteins in polished rice, based on experiments with rats, has been reported in India, where considerable attention has been given to the study of rice proteins. Similar experiments on rats elsewhere, with a 5 per cent level of protein intake, indicated biological values of 73 and 72 for rice and corn proteins respectively, while the corresponding ualue was only 67 for wheat protein with an 8 per cent level of intake. There is also evidence, based on rat experiments, that the proteins in polished rice are superior to the proteins of enriched wheat flour. Though very few human experiments have been made, it has been stated that rice flour protein has the high biological value of 83–86 for man.

The results of two further relevant series of experiments with rats may be referred to here. The digestibility of proteins in both whole and milled rice has been found to be high, namely 96.5 and 98 per cent respectively. The supplementation of rice with milk powder results in the better utilization of rice proteins; and proteins of meat and fish, and soya bean in digestible form supplement those of rice.

Vitamins

The amounts of fat-soluble vitamins A and D in rice are negligible, as in other cereals. On the other hand, the vitamin E content of whole rice is considerable. Whole rice compares well with whole wheat as a source of water-soluble vitamins, but wheat, especially high protein varieties, has a higher thiamine content. The riboflavin content of rice is low and vitamin C is practically absent. The average thiamine, riboflavin, and niacin content of 13 varieties of brown (husked) rice has been reported to be 3,550.60, and 53.08 micrograms respectively per gram. The results of another investigation gave the following average values for 6 varieties: 4.2 micrograms of thiamine, 0.61 micrograms of riboflavin and 47.2 micrograms of niacin per gram. In experiments on reproduction and lactation in rats, rice and its by-products have been found to be good sources of pantothenic acid and pyridoxine, two other vitamins in the B complex. Husked rice was reported to be a better source of pyridoxine and insoitol for rats than polished rice, but no significant differences were found with regard to pantothenic acid and aminobenzoic acid.

Other Nutrients

Rice, like wheat, is a poor source of fat, and milling removes most of the fat from both cereals. Whole maize is richer in fat than whole rice or wheat. In its mineral content, rice resembles other cereals. It is poor in iron and calcium and the calcium-phosphorus ratio is unfavourable being about 1 : 10 instead of 1:2 which has been regarded as the optimum ratio.

The general conclusion may be drawn that whole rice has nutritional properties approximately similar to those of other cereals in a similar state; it is somewhat superior in certain respects, but inferior in others. Like all cereals, it is not a complete food, and a diet containing only rice will not provide all the nutrients needed by human beings. Rice should, therefore, be supplemented by other foods which can supply additional amounts of protein, fat and various vitamins and minerals.

The available literature on the effect of variety of soils, fertilizers, and methods of cultivation on the nutrient content of rice is scanty. Observations in India on the relationship between variety and nutrient content show that coloured and coarser varieties contain larger amounts of proteins and minerals, particularly calcium and prosphorus. It has also been claimed that rice of coloured varieties supports better growth in experimental animals than rice of uncoloured varieties. Investigations in Java, however, have shown that the white varieties of rice, i.e., those with a white pericarp and aleurone layer, have much the same composition as coloured varieties. A study of the B vitamins in rice and its milled products indicated slight differences when figures for individual varieties were compared with average values. Long-grain varieties, like Nira and Fortuna, were highest in vitamin content. Rexoro and Blue Rose occupied an intermediate position, and the shorter grained varieties, a lower position. Early Prolific and American Peal, were lowest. While the problem has not yet been sufficiently investigated, there is as yet no convincing evidence that certain varieties of rice are strikingly superior to others in nutrient content.

Vitamin-B_1 In Rice

Typical Indian diets are largely composed of one or other of the staple grains of the country, supplementary foods, such as vegetables, fruit, dairy products, and meat, being consumed only in small quantities. Most of the Vitamin B_1 supplied by such diets is obtained from the cereals and pulses. Cereals as a group have a relatively high vitamin-B_1 content while the supplementary foods mentioned above are not rich in the vitamin. The intake of pulses, which are also a good source of vitamin B_1, is small in most parts of India.

In studying the problem of vitamin-B_1 deficiency, particular attention must, therefore, be paid to the vitamin-B_1 content of

cereals. The following Table shows the vitamin-B_1 content of Rice and other cereals:

Vitamin-B_1 Content Of Various Staple Foodstuffs determined by the Bradycardia and Thiochromeme thod.

Foodstuff	Bradycardia method	Thiochrome method
Wheat	4.3	5.3
Cholam (Sorghum Vulgare) :-		
Sample 1	2.3	2.9
Sample 2	–	2.8
Cambu (Pennisetum typhoideum)		
Ragi (Eleusine coracana) :-		
Sample 1	1.5	3.9
Sample 2	–	3.0
Rice:-		
Raw Home-pounded	1.6	2.3
Raw milled	0.7	1.1
Parboiled home-pounded	2.5	2.9
Parboiled milled	1.6	...
Tapioca	0·5	0.6
Potato	0.8	0.8

The *thiochrome* values are, it is contended, more likely to be correct than those obtained by the *Bradycardia* method. The lower figures given by the latter may perhaps be due to the inability of animals used for the assay, sick as a result of vitamin B_1 deprivation, to absorb completely or utilize the vitamin present in the test dose of the foodstuffs.

Whole wheat, cambu, cholam, and ragi contain from 3 to 5 micrograms of vitamin B_1 per g. These are high values compared with those given by most foodstuffs. The amount present in rice depends on the degree of milling and whether the rice is parboiled or not. Accordingly, the vitamin-B_1 content of a number of varieties of rice in common use in South India, raw and parboiled, and in various stages of milling, has been investigated. Eight varieties were obtained for the experiment. The following processes were applied to some or all of these in both the raw and parboiled states :

Husking in a wooden grinder.
Husking in a Japanese Huller.
Home Pounding.
Machine Milling.

The Vitamin B_1 content of 8 varieties of rice treated in different ways.

(Micrograms/grams of rice)

Variety	RAW				PARBOILD	
	Wooden grinder	Japanese-huller	Hand-pounded	Machine Milled	Hand-pounded	Machine milled
Vadan Samba	2.3	2.5	2.1	0.6	2.1	2.1
CO 9	3.2	3.7	2.9	1.3	2.4	2.0
ADT 2	3.3	2.7	1.5	1.3	2.7	2.6
ADT II	2.6	2.9	2.1	1.3	2.4	1.6
GEB 24	3.2	2.9	2.1	1.3	2.0	1.7
CO 5: Sample 1	–	–	3.9	1.2	–	2.9
Sample 2	–	–	2.5	0.8	2.7	1.9
CO 2	–	–	2.3	0.9	2.5	2.1
CO 7	–	–	2.4	0.9	2.4	2.6
Average	2.9	2.9	2.4	1.0	2.4	2.2

The effect of machine-milling is clearly shown in the Table. Both raw and parboiled samples were apparently milled to about the same extent, corresponding roughly to that reached in ordinary commercial practice. With the raw rice, some two-thirds of the vitamins originally present were removed on milling, while in the case of the parboiled samples the loss was only about one-third. The lowering of vitamin content which takes place when raw rice is milled is strikingly illustrated in the Table below. This shows the repeated losses in a sample of raw rice, originally rich in the vitamin, as it passes through the various stages in a modern rice mill. Less than 20 per cent of the vitamin originally present finally remains.

Vitamin B content of rice (Krishnakutulu variety) at different stages of milling.

(Micrograms/gramme of rice)

Shelled only	4.0
Once polished	1.8
Twice polished	1.0
Thrice polished (ready for market)	0.7

The following table shows the Vitamin B_1 content of samples of rice of various kinds.

The Vitamin B_1 content of miscellaneous samples of rice (Micrograms/gramme of rice)

Shelled only (constant irrigation during growth)		4.0
Shelled only (intermittent irrigation during growth)		4.2
Highly milled raw rice from Siam		1.1
Highly milled broken raw rice from Burma		0.5
Milled raw rice from Hyderabad		1.2
Parboiled milled	Rice from Cannanore	1.7
	Rice from Anamallais	2.1
	Rice from Lawley Hospital, Coonoor	2.2

Much of the rice consumed in South India is parboiled rice, milled to a fairly high degree. Since the relation between milling and the vitamin B_1 content of parboiled rice is of essential importance, careful re-investigation of the problem, using the Thiochrome method of assaying vitamin B_1, has been carried out. The loss of weight occurring in samples of rice, subjected to milling was used as a criterion of the degree of milling. Two varieties of rice were used Co 9, a large-grained red rice, and ADT 2, a small-grained white rice. These varieties, in the raw and parboiled state, were milled to various degrees and the vitamin B_1 content of the resulting Samples determined. The experiment clearly showed that parboiled rice retains vitamin B_1 even when very highly milled. When the degree of milling was 17 to 22 per cent, the values for the raw rice samples were all below 1.0 microgram/gramme, whereas those for the parboiled samples lay between 2.0 and 3.0. These results obtained in the earlier investigation can be roughly converted into terms of crystalline vitamin B_1 as follows :

Vitaman B_1

(Micrograms/gramme)

	Raw	Parboiled
Whole rice	2.3	2.6
Milled rice	None detected	1.6

Since parboiled rice contains more Vitamin B_1 than raw, it follows that the millings removed from the former will be poorer in the vitamin than those removed from the latter. Bran removed from Co 9 in the raw and parboiled state during milling in the machine for various periods was tested; the samples so obtained represent different layers of the grain. In the case of ADT 2 the entire millings obtained by milling 17 to 18 per cent by weight of the original husked rices were tested. The results are given below :

The Vitamin-B_1 content of millings from the raw and parboiled rice

(Micrograms/gramme)

Duration of milling (minutes)	Bran from raw rice.	Bran from Parboiled rice.
	Co9	
0.5	45	25
5–10	55	16
10–15	23	15
15–20	11	11
	ADT 2 Total Millings	
0–20	26.5	6

The outer layers removed in succession from raw rice are rich in Vitamin B_1, the values falling off in the layers which lie more deeply. With parboiled rice, in contrast, the outermost layers contain much less vitamin B_1 and there is a less marked decrease in the value of the inner layers. Since parboiled rice is tougher and more difficult to mill than raw rice, the layers removed after 5 minutes, 10 minutes, etc; do not represent precisely the same parts of the grain in the raw and parboiled samples. In parboiling the endosperm gains vitamin B_1 at the expense of the pericarp.

The Vitamin-B_1 Content Of Foodstuffs Other Than Cereals

The extensive determinations of the vitamin-B_1 content of Indian foodstuffs have been made by Ghosh and Guha (1933-1934)

and by Wilson (1937). These groups of workers each assayed about 40 foods using the rat-growth method in its modern form. They compared the potency of test substances with that of the international vitamin-B_1 standard, stating results in International Units. Their values, converted into amounts of pure vitamin on the assumption that the International Unit is equivalent to 3.0 micrograms of the pure vitamin, show that, apart from Bengal fish, foods of animal origin, e.g., milk and meat have not been assayed in India. For these foods 'preferred values' of Williams and Spies (1938) have been given. It is unlikely that the vitamin-B_1 content of meat should show material variations in different parts of the world. All workers who have investigated the question are agreed that milk is not a rich source.

The 'preferred value' of Williams and Spies is based on a critical assessment of the figures available. It is defined as 'the most trustworthy value' and is adjusted for changes occurring in the preparation of food for consumption (but not for losses in cooking). In assigning 'preferred values' to certain Indian foodstuffs, their example has been followed.

It has been shown that, in the case of rice, considerable losses in vitamin-B_1 content occur during washing and cooking. In calculating the vitamin-B_1 of diets based on a rice staple from data obtained in diet surveys, etc. the values assigned to rice may be roughly 50 per cent of that given in the Table below. With other foods some losses will occur in preparation and cooking, but, in general, these will be of a smaller order than those which occur in the case of rice. Since supplementary foods are included in typical rice diets in only small quantities, any reduction of their vitamin-B_1 content, during preparation, will not greatly influence total vitamin-B_1 intake, and may conveniently be ignored in the calculation and assessment of diets.

Vitaman-B_1 content of various foodstuffs
(Micrograms/gramme of parts per million)

A. Cereals

	Preferred Value
Rice :—	
Raw home-pounded	2.4
Raw machine milled	1.0
Parboiled home-pounded	2.4
Parboiled milled	2.2
Millets : (ragi, cholam, cambu)	3.0
Wheat :—	
Whole flour	4.5
White flour	0.5

Nicotinic Acid Content Of Rice

It has recently been shown that nicotinic acid is an essential dietary constituent and an important member of the B_2 group of vitamins. Its remarkable effect in the treatment of pellagra has been conclusively demonstrated. A chemical method for the assay of nicotinic acid has been developed and applied to a large number of foodstuffs. During the investigation of the vitamin-B_1 content of rices, parallel estimations of nicotinic acid were carried out. The effect of milling and parboiling on the nicotinic acid content of rice has been studied and light thrown on the distribution of this factor in the grain

The nicotinic acid content of husked rice, i. e., rice which retains germ and pericarp almost intact, is 4 mg. per cent. Raw rice when pounded loses about half the nicotinic acid originally present and when machine-milled about two-thirds. This shows that most of the nicotinic acid in the rice grain is concentrated in the germ and pericarp.

Nicotinic Acid content of varieties of rice
(Mg./100 g. of rice)

Variety	Raw			Parboiled	
	Home-pounded	Milled	Husked	Home-pounded	Milled
Vadan Samba	..	1.5	..	...	3.5
Co 9	..	1.5	4.6	...	3.1
ADT 2	..	1.6	4.3	..	3.6
ADT II	2.1	1.7	4.0	4.0	3.6
GEB 24	..	2.3	..	..	4.8
Co 5½					
Sample 1	..	1.8	..	..	4.7
Sample 2	2.2	1.1	..	3.8	3.4
Co 2	2.8	1.3	..	4.6	4.1
C0 7	2.7	1.7	..	3.3	3.0
Average	2.4	1.6	4.3	4.0	3.8

When rice is parboiled, on the other hand, little nicotinic acid is lost on pounding and milling, indicating that nicotinic acid diffuses through the grain in the same way as vitamin B_1. Parboiled rice even when very highly milled, retained more than 3 mg. of nicotinic acid per cent.

Washing and cooking produce losses of nicotinic acid compared to those occurring in the case of vitamin B_1 about 40 per cent passing into the wash-water and *conjee.* The nicotinic acid content of cooked parboiled milled rice and raw milled rice is of the order of 1.4 mg., 1.8 mg., and 0.4 mg. to 0.6 mg. per cent respectively. In most of the samples of rice tested, the nicotinic acid content was 10 to 20 times the vitamin B_1 content.

These results emphasise the importance of the effect of milling, parboiling, washing, and cooking on the nutritive value of

rice. Presumably other water soluble factors, which may be concentrated in the outer layers, tend to behave in the same way as vitamin B_1 and nicotinic acid. The content or rice in other factors in the vitamin-B_2 complex, including riboflavine, Vitamin B6, the so-called filtrate factors and other constituents, requires further investigation. At present information about human requirements of these factor and their clinical importance is lacking or limited. It is, however, probable that rice is a poor source of various factors in the vitamin-B_2 complex other than nicotinic acid, and this fact may prove, to be of considerable practical significance. The determinations of nicotinic acid recorded here are of interest in connection with the aetiology of pellagra.

Vitamin A and C

Rice contains very little carotene, the precursor of vitamin A. Average homepounded rice contains about 10 International Units of vitamin A (carotene) per 100 g. while highly-milled rice is almost completely devoid of this vitamin. Six hundred grammes of home-pounded rice—an amount corresponding roughly to adult daily intake—may thus supply about 60 International Units of vitamin A. Since daily requirements have been assessed at about 3,000 International Units, it is clear that rice in any shape or form is an unimportant source of the vitamin. Unless the rice-eater consumes supplementary foods such as whole milk, vegetables and fruit in reasonable quantities, his diet will be deficient in vitamin A; the prevalence in India of conditions associated with vitamin 'A' deficiency lends point to this statement.

Rice contains no vitamin C. Presumably it would develop this vitamin on germination, but germinated rice is never used as an article of diet.

Loss On Cooking

Most of food factors present in rice are, however, little affected by the degree of heat used in cooking. Many are, however, readily soluble in water, and losses occur in the preparation of

rice. The extent of the loss depends on the amount of water and the number of times it is washed before cooking, and wether the cooking water is discarded or consumed. Methods of preparation and cooking differ from place to place and from household to household, so that only an approximate estimate of the losses which occur can be given. From an extensive study (1937) it may be concluded that losses from washing and cooking are of the following order :

Calories	...	...	15 per cent
Protein	...	...	10 per cent
Iron	...	...	75 per cent
Calcium and phosphorus	...	...	50 per cent

The loss of fat is about 50 per cent, but uncooked rice contains so little fat that losses on cooking are of no great importance.

While the protein present in rice is not seriously reduced during preparation, a considerable percentage of the calcium, phosphorus, and iron originally present is lost. Similar losses occur in the case of Vitamin B_1 and Nicotinic Acid. It is the preliminary washing of rice which causes most of the loss in nutritive elements.

The Effect Of Washing And Cooking

Further losses of vitamin B_2 and other food factors, in addition to the losses on milling, occur in the washing and cooking of rice. These processes vary widely from house to house, and satisfactory investigation of the losses which they involve is difficult. The loss in rices prepared for consumption in the following way has, however, been estimated :

Two hundred g. (7 oz.) of rice were washed thrice each time with approximately 300 ml. (11 oz.) of water, the whole process taking about five minutes. The rice was then added to

1,400 ml. (50 oz.) boiling water and cooked until fit for consumption. The *conjee* (cooking water) was then decanted off and measured, the volume in most cases being nearly one litre (35 oz.). The vitamin-B_1 content of the cooked rice, washing and conjee was determined as shown in the following Table :-

The effect of washing and cooking
(Vitamin B_1 micrograms/gramme)

Rice	Uncooked rice	Washed and cooked rice	Percent of Vitamin remaining in coked rice	Percent of vitamin present in conjee	Percent of Vitamin present in washing
Co 5					
Raw home pounded	2.5	0.6	25	...	...
Raw milled	0.8	0.2	25	...	...
Parboiled home-pounded	2.7	1.0	35	...	...
Parboiled milled	1.9	0.9	50	...	...
Co 2					
Raw home-pouded	2.3	0.7	33	33	33
Raw milled	0.0	0.1	15	30	35
Parboiled home-pounded	2.5	1.6	60	30	10
Parboiled milled	2.1	1.0	45	15	40
Co 7					
Raw home-pounded	2.4	1.0	40	...	..
Raw milled	0.9	0.3	35	...	...
Parboiled home-pounded	2.4	1.1	45	...	...
Parboiled milled	2.6	1.1	40	...	...
Imported broken raw milled Burma Rice	0.5	0.2	30	10	60
Average	..	..	35	..	..

The Vitamin present in the uncooked rice could all be accounted for in the washing, *conjee*, and cooked rice. No vitamin was destroyed. A large proportion passed into the wash-water and *conjee*. On an average only 35 per cent remained in the cooked samples. There was some indication that the Vitamin can be more readily washed out of raw than parboiled samples. A large quantity of water was used in the washing and cooking in these experiments and the loss of 65 per cent probably represents a maximum. The usual loss may be estimated as 50 per cent.

McCarrison and Norris showed by pigeon tests that considerable loss of vitamin B_1 occurs when rice is washed. This point has also been investigated in Java by Van Veen (1933) who used biological tests with Java sparrows as a method of assay. Some of his results which were originally expressed in International Units are shown in the Table below. The agreement between his figures and those given above is remarkably close, and suggests that the effect of washing and cooking is much the same with all varieties of rice.

Vitamin B_1 content of Javanese rices
(Micrograms / gramme)

(Assuming 1.0 = 3 micrograms of vitamin B_1)

Rice	Husked, not milled rice	Under-milled rice	Polished rice
In the original condition	2.4–3.0	1.5-2.4	0.6–1.2
After washing	1.5–1.8	0.8–1.2	0.6
After prolonged washing	..	Well below 0.6	Well below 0.6

It is clear that losses of the vitamin produced by washing and cooking are as significant as those produced by milling. Much

more passes into the wash-water than into the *conjee*. An illustration of the variety of these results in practice has recently been supplied by Platt (1939), who describes the following experiment on a group of factory workers in Shanghai:

"One group of workers was fed on rice freshly and highly milled each day and cooked without preliminary washing. Control groups were observed, fed on rice milled to a similar degree, but washed thoroughly in the ordinary way. Side dishes and other conditions were comparable in all the groups. No signs of *beri–beri* developed in the group on the unwashed rice, whereas in the control groups nearly half the subjects developed signs attributable to vitamin-B_1 deficiency".

Platt considers the elimination of washing and of the use of superfluous water in cooking of great importance in connection with the prevention of vitamin-B_1 deficiency in rice-eaters.

Digestibility of Rice

Several studies have been made of the effect of digestive ferments, such as takadiastase, pancreatic and salivary amylases, on the starch present in freshly harvested and stored rice, raw and parboiled rice, etc., in order to throw light on the digestibility of rice in various states. It is common, in the course of any discussion on rice with laymen, to be told that this rice is indigestible or that another variety causes unpleasant gastric disturbances. The rice accused of producing these unfortunate consequences is often one consumed by millions of people without complaints. The truth probably is that all ordinary rice and rice preparations can be digested satisfactorily by healthy people. The human stomach (or more probably the human mind) is essentially conservative and any change in the diet is temporarily resented. But within a few days or weeks all but the staunchest diehards can adapt themselves to any form of rice. Similar ineffectual arguments about the relative digestibility of white and brown bread occur in wheat eating countries.

4

Beri-Beri And Rice

Over sixty years ago, Admiral Takaki, a Naval Surgeon, succeeded in eliminating *beri-beri* from the Japanese Navy by partially replacing milled rice in the diet of the sailors by barley and wheat. Entering the Japanese Navy in 1872, Takaki immediately became interested in *beri-beri*, which at that time was the major cause of sickness and death among the sailors. After studying the disease for a number of years, he finally became convinced of its dietary origin and, acting on this hypothesis in 1884 and 1885, replaced a part of the rice in the ration by wheat and bread and increased the allowance of vegetables and milk per man. There was striking reduction in the incidence of, and mortality from, the disease, which is shown in the Table below :

Beri-Beri In The Japanese Navy

Year	Force	Cases of Berri-Beri	Deaths
1878	4,528	1,485	32
1879	5,081	1,978	57
1880	4,956	1,725	27
1881	4,641	1,163	30
1882	4,769	1,929	51
1883	5,346	1,236	40
1884	5,638	718	8
1885	6,918	41	0
1886	8,475	3	0
1887	9,106	0	0

Takaki himself attributed the improvement to an increase in protein intake. The well-known researches of Eykman and Gryns in Java from 1890–1900 made it clear that *beri-beri* is a food

deficiency disease associated with the consumption of milled rice and that it can be prevented by replacing milled rice by husked rice or undermilled rice. Other workers, including Frazer, Stanton, Vedder, and Braddon made substantial contributions to the problem and a number of convincing human experiments were made. For example, when in 1910 under-milled rice was given to the Phillippine Scouts in place of polished rice, the incidence of *beri-beri* fell from 10 to 1 per cent within a year, and *beri-beri* disappeared from Javanese prisons when husked rice was introduced. It was observed that *beri-beri* was rare in areas in which home-pounded rice was eaten, Braddon was the first to draw attention to the fact that people who eat parboiled rice rarely contact *beri-beri*, an observation of great importance.

Parboiling And Milling.

Braddon (1908) showed, by a painstaking epidomiclogical inquiry, that those who eat parboiled rice usually escape *beri-beri*. In a number of early *beri-beri* experiments it was shown that the disease can be prevented or eliminated by replacing raw milled rice by parboiled rice. The parboiled rice associated with two investigations was usually hand-pounded or under-milled, and it was generally assumed that its effect in preventing *beri-beri* was due to under-milling. Later, the investigations of Aykroyd (1932) threw fresh light on the *beri-beri* preventing properties of parboiled rice. It was shown by animal experiments that parboiled rice retains a considerable proportion of its vitamin B_1 content even when highly milled. The suggestion was made that, during the process of steaming, some of the vitamin contained in the germ of pericarp diffuses through the grain and cannot be removed by subsequent milling. Braddon's studies of the epidemiology of *beri-beri*, are of considerable historical importance. Braddon working in the Federated Malay States, was struck by the fact that the susceptibility to *beri-beri* of Chinese and Tamil emigrants in Malaya was very different; the Chinese suffered severely from the disease, while

Tamils, on the other hand, preferred rice prepared in the Indian fashion, i. e., parboiled before husking. Starting from this observation, Braddon showed that throughout the East the consumption of raw milled rice was associated with *beri-beri*, while those who consumed parboiled rice were usually immune from the disease. His explanation was that steaming destroyed some toxin present in rice.

Role of Diet

Further human experiments demonstrating the role of diet in the causation of *beri-beri* were carried out in the Malay States by Fletcher (1907), by Fraser and Stanton (1909), and in the Phillippine Islands by Chamberlain (1911). Fletcher, working in the Mental Asylum at Kuala Lumpur, showed experimentally that *beri-beri* could be almost completely eradicated by substituting parboiled rice for highly-milled-raw rice. The patients were divided into groups at random and assigned to different wards in the hospital. The results are shown in the table below:

Observations on patients in Kuala Lumpur Asylum (1907)

	Number of patients.	Cases of beri-beri	Deaths
East Ward. Diet mainly raw polished rice	124	34	18
West Ward. Diet mainly parboiled rice	123	2	0

The experiments of Fraser and Stanton were equally striking Two parties of coolies were taken into the heart of jungle and employed in road making at a distance of 7 miles from each other. One party, consisting of 220 was given white milled rice, while the other was given parboiled rice. Apart from rice, the diet contained small quantities of salt fish, onions, potatoes, and coconuts. Within 6 months, 20

cases of *beri-beri* occured in the first group, while the second remained free from the disease. Conditions were now reversed the first party receiving parboiled rice, the second milled. The outbreak of *beri-beri* in the former abruptly ceased, while cases of *beri-beri* now appeared in the latter.

Chamberlain and Vedder eliminated *beri-beri* from the Philippine Scouts by the substitution of unpolished rice and a little pulse for the highly milled rice which previously formed the greater part of the ration (see Table below):

Beri-Beri in the Philippine Scouts

Year	Diet	No. of beri-beri case
1909	8 oz. potatoes, 12 oz. beef, 8 oz. white flour plus 20 oz. ordinary (Polished) rice	610
1911	8 oz. potatoes. 12 oz. beef, 8 oz. white flour plus 16 oz. unpolished rice plus 1.6 oz. dried beans.	3
1913	8 oz. potatoes, 12 oz. beef, 8 oz. white flour plus 1.6 oz. unpolished rice plus 1.6 oz. dried beans.	0

Apart from such spectacular and convencing experiments, there are numerous instances on record of the eradication of *beri-beri* from an institution or a group of men living on a diet, based largely on milled rice, by means of a comparatively small change in the nature of the diet, e.g., the addition of some wheat or pulse, or the substitution of under-milled or parboiled for highly milled rice.

From the beginning of the century onwards, laboratory experiments with fowls and pigeons stimulated and confirmed experiments in human *beri-beri* and *vice versa*. The early investigations on the aetiology of *beri-beri* which were carried out in Far Eastern countries were of great importance in the development of the modern science of nutrition.

Epidemiology

Beri-Beri occurs throughout the rice-eating countries of the East. In India, however, the extent of the disease, relative to the total number of rice-eaters, has always been slight in comparison with that observed in Malaya, Indo-china, Thailand, Japan and the Philippines. Although rice is the staple cereal of over half the population of India and *beri-beri* is known to be a disease associated with ill- balanced rice diets, in most parts of the country typical *beri-beri* is unknown, or only occasional cases of outbreaks occur. As an endemic disease it is limited to an area in the North-East coast, the Northern Circars including the Ganjam, Vizagapatam, Godavari, Kistna, Guntur and Nellore districts. In other parts of the country only sporadic outbreaks occur.

Beri-Beri in the Madras State (Undivided)

Year	Northern Circars (Beri-Beri Area) Population 13.9 Mllas.		Remainder of Madras State (Population 32.9 Millions).	
	Cases	Deaths	Cases	Deaths
1932	16,091	93	665	3
1933	20,513	55	822	2
1934	21,849	42	711	5
1935	34,649	89	382	8
1936	20,814	94	452	7
1937	27,488	65	748	5
1938	32,717	64	649	4

It will be seen that although the population of the '*beri-beri* areas' is only 30 per cent of the total population of the Madras Presidency, 95 per cent of the cases of *beri-beri* occur in these areas. The figures represent cases applying for medical treatment in hospiltals and dispensaries and thus give only a rough indication of the incidence of the disease.

An essential difference between the food habits of the people in the *beri-beri* area and those followed in other rice eating areas of Madras is that in the former raw rice is preferred. The

mills in the *beri-beri* area produce some parboiled rice, but this is mainly for export to other parts of State. In Bengal, Assam, Bihar and Orissa, and the remainder of the Madras State parboild rice is usually consumed by the poorer classes; this may be home pounded, but much of it, particularly in Madras, is machine milled rice. The superiority of parboiled milled rice over raw milled rice in Vitamin–B_1 content thus appears to explain the epidemiology of *beri-beri* in India.

An illustration of the effect of parboiled rice in preventing *beri-beri* is given by Taylor, Martin and Thant (1928). The crews of the Burma lighthouse up to 1911 were all supplied with raw milled rice. In May 1911 parboiled rice was substituted and the result is shown below :

The incidence of beri–beri amongst the crews of lighthouse on the Burma coast

Year	Cases	Deaths
1904–1905	13	2
1905–1906	14	1
1906–1907	24	3
1907–1908	8	–
1908–1909	25	2
1909–1910	39	6
1910–1911	18	1
1911–1912	1	–
1912–1913	2	–
1913–1914	–	–

Although *beri-beri* is usually associated with a rice diet, this is not always so. It may occur when any highly milled cereal forms an excessive proportion of the diet. Examples are available of the occurrence of *beri-beri* in groups consuming highly milled wheat. Beri–Beri is found in New Foundland and Labrador among fishermen consuming a diet largely composed of refined wheat flour.

Aetiology

In the past, Indian medical literature has contained many

discussions and controversies about the cause of *beri-beri*. Three alternative views have been advanced. One was that *beri–beri* is a deficiency disease caused by the use of rice from which the germ and pericarp had been largely removed in the milling process and containing the antineuritic vitamin in insufficient quantities. Another view was that it is due to an infective organism associated with, and spread by, bad rice. The third was that the signs and symptoms are produced by a toxin present in rice which has been stored for a long time. Extensive laboratory, clinical, and field investigations, carried out all over the world, have shown beyond any reasonable doubt that the first alternative is correct.

The composition of any cereal is altered by milling which partially or completely removes the outer layers which are richer in various food elements than the starchy endosperm. The extent to which any given kind of cereal can be deprived of integuments is influenced by the shape, size, and other factors. The shape and consistency of the rice grain are such that an almost complete separation can be easily brought about by simple mechanical means. In nutritive value, milled rice stands low among the cereal products, milled or unmilled, which forms the staple foods of mankind.

During the early years of the present century, much attention was given to the problem of *beri-beri*. Research clearly demonstrated the anti-*beri-beri* properties of under-milled rice and indicated a method of preventing the disease. But the substitution of milled rice by rice not deprived of its outer layers was found to be difficult in practice for a number of reasons. Many varieties of rice have a reddish-brown pericarp and aleurone layer. When these varieties are milled to a high degree the brown pericarp is removed and white rice is produced. The latter is considered more attractive in appearance and is preferred by the well–to–do even in areas where the greater part of the rice consumed is

home-pounded. A certain 'social status' is thus associated with white rice and those who are used to it are reluctant to change their habits. Moreover, under-milled rice (as well as parboiled rice) has a distinctive flavour and taste not possessed by white rice and people accustomed to the latter do not relish the former. * Another important point is that the keeping of milled rice are superior to those of husked or under-milled rice so that the general use of the latter raises various difficult problems of transport and storage. The rice milling industry is organised to produce milled rice and has naturally resisted attempts to encourage the consumption of under-milled rice.

International and Inter-Governmental Action

The recognition of the cause of *beri-beri* led to its prevention in institutions among communally-fed groups whose diet could be controlled. Relatively satisfactory methods of treating the disease (e. g. with extracts of rice polishings) were evolved. But little progress was made in preventing the occurrence of the disease among the general population of rice-eating countries. Discussions at meetings of the Far Eastern Association of Tropical Medicine in 1921 and 1923 in Batavia and Singapore respectively are illustrative of the situation at that time.

These discussions may be summarised as follows: Rice milling legislation was regarded as premature, since the problems involved had not been fully studied. The introduction of undermilled rice was not recommended because of the bad-keeping qualities of this kind of rice and lack of knowledge supplied in Government institutions. Efforts to popularise the use of under-milled rice by education and propaganda should be

* The converse is also true. For example, during the Japanese occupation of the Far East, European prisoners of war became accustomed, after strong initial protests, to husked or under-milled rice. When they changed over to highly milled rice, they often found that they had developed a preference for undermilled rice and that milled rice appeared to be tasteless.

increased. It deplored the increasing tendency of urban and rural populations in the East to consume highly milled rice. It strongly recommended that Government should make a thorough investigation of the nutritional, commercial, economic, and psychological aspects of the problem, attention being given to the possibility of checking the spread of mechanical rice mills in rural areas, with a view to conserving the healthy habit of consuming home pounded rice, and to the means of making under-milled rice easily available everywhere for those who wished to purchase it.

Resolutions of this kind have not so far resulted in effective action, although attempts have been made here and there to teach people to eat undermilled instead of milled rice. The whole problem needs re-examination in the light of modern knowledge and the experience gained in certain countries. Research has shown that there are other ways of conserving the vitamin content of rice besides milling the grain in such a way that sufficient proportion of the grain richest in thiamine and other nutrients is retained in the milled product; for example, parboiling and 'conversion.' The large-scale manufacture of vitamins in the pure state has created the possibility of adding to milled rice some of the vitamins which it lacks, or of introducing them into the diet in other ways. Further, it is becoming clear that, while the substitution of milled rice by rice of higher nutrient content would represent an important improvement, diets which are composed largely of rice of any kind are ill-balanced and need to be supplemented adequately by other kinds of food. The cause of *beri-beri* has been known for many years, but this knowledge has not yet led to the eradication of *beri-beri* or to the general improvement of rice diets.

Psychological Factors

The well-to-do in South India in general prefer their rice white and well polished because they consider such rice more palatable and aesthetically more pleasing than coarser varieties. How far is the present tendency on the

part of the mass of the population to adopt the use of highly-milled rice influenced by the example of the more prosperous classess ? We may recall that in Europe the example of the well to do was a potent factor in establishing a preference for highly-milled wheat flour throughout the population. During the discussion on the rice problem at the League of Nations Java Conference a number of speakers insisted that one of the most important reasons why the poorer classes in the East have taken to milled rice is because it is, so to speak, fashionable.

The Java Conference recommended that only home-pounded rice or under-milled rice should be used in all Government Institutions. This may be applied equally to the case of raw and parboiled rice, and may be extended to all private residential hostels. The Government of Madras has recently made the use of handpounded rice compulsory in Jails and hospitals with the dual object of improving the diet and of creating employment. In the jails the rice is pounded by the prisoners themselves. No standards defining what is meant by handpounded rice have been laid down. Hence contractors may be tempted to supply cheap Burma rice with a small admixture of under-milled grain and call it handpounded. Superintendents of institutions can, however, readily learn to distinguish handpounded from machine milled rice by inspection and thus prevent this-kind of fraud. Non-Governmental institutions can follow the above practice.

What has been done by the Madras Government can be emulated by other State Governments and institutions. If it is generally known Government preference is for handpounded rice, a return to the old habit by masses of people will be facilitated. Moreover, a declaration from the Ministeries of Health at the Centre and in the States that consideration of National Health makes it imperative to promote and popularise handpounded, preferably parboiled, rice, will check the spread of rice mills and encourage handpounding even on a large commercial scale.

CHAPTER V.

THE RICE INDUSTRY

1

Parboiling of Rice

Before the paddy is husked it is the custom in many areas for the grain to be first subjected to a treatment which includes steeping in water and the subsequent application of heat by steam or other direct means. This method is known as par-boiling. This makes the husk more easily removable and toughens the rice kernel, enabling it the better to withstand hulling or milling. The outturn of whole rice from parboiled paddy is invariably and often markedly greater than that from paddy which has not been so treated.

It is not known when paddy first came to be parboiled, but it is fairly certain that the practice is almost as old as the ordinary methods of cooking rice by boiling it in water. Commercial parboiling existed on a relatively smallscale prior to the war of 1914–18, but greatly increased thereafter until, by 1937 some 57 per cent of the total Indian production (less seed) was estimated to be parboiled. The methods adopted in parboiling are in all main essentials the same, but the equipment used and the time of steeping and heating vary in different areas. The crudest and most primitive system is that practised in the home by consumers themselves. In such cases, the paddy is intended for hand-husking and not for machine-milling. The product is placed in a tin canister–the ubiquitous kerosene oil tin is often used, brass utensil, or earthenware pot, and covered with water. The container is then stood over a fire and the water brought to the boil. When the paddy grain has swollen a little and has become soft, a stage which is usually reached when a few grains have burst, it is regarded as sufficiently treated. The surplus water

is poured off and the paddy spread out on the floor to dry.

A more elaborate method adopted in many parts of West Bengal is to bring the paddy to the boil, remove it before it has been on the boil for more than a few minutes, transfer the grain to a cold water steep of from 24 to 36 hours and finally boil it again. After the last boiling, it is thoroughly dried and is then ready for husking.

In some districts of the Punjab, the paddy is kept heated in water for a period of about 24 hours over a smouldering fire of paddy husk. It is removed, mixed with a little sand and then roasted in an iron pan for about five minutes over a strong fire. The mixture of paddy and sand is kept well agitated during the roasting process after which it is spread out in the sun to dry out thoroughly before dehusking.

A somewhat similar procedure is adopted in Uttar Pradesh.

Commercial parboiling implies the handling of considerable quantities of paddy. Large cement tanks are used for the steeping of the paddy and cast iron cylindrical containers for the steaming process. Two main systems of parboiling are in vogue which may, for convenience, be termed the 'double' and 'single' steaming processes. In the first, the paddy is placed dry in the cylindrical containers into which a steam pipe projects. Steam is introduced under low pressure for about one minute if a light colour is desired in the finished product, and for five minutes for a darker or yellow colour. The paddy is then transferred to the steeping tanks into which cold water is poured and left there for 18 to 26 hours. The water is drained off at the end of the steeping period and the paddy is put back into the steaming cylinders and given a second application of steam for approximately five minutes (for a light coloured rice). Some small variations in the steaming and steeping times are given, but this depends on the skill and experience of the operator. The paddy is then removed and spread out thinly on drying floors.

These generelly have a surface of cement. Sometimes, however, the paddy is spread on mats where cement floors are situated in the open air whithin the premises.

A slight modification is, sometimes, used to obtain a darker colour in the finished product. After the first steaming, the paddy is not immediately steeped in water, but is taken out of the steaming cylinders and covered up with gunny bags for 6 to 8 hours at the expiry of which the steeping and second steaming process follows in the normal way.

The second or "single" steaming method consists of steeping the paddy in water for one to three days and following it up with an application of steam for anything up to ten minutes. The paddy is then dried as usual. This method is widely adopted where a light coloured product is desired.

Both methods are used wherever parboiling is done on a large-scale, but the "double" steaming process is perhaps more common in West Bengal, Bihar, Orissa, Madras and Mysore.

There is yet another system confined mainly to the Saharanpur district in Uttar Pradesh where high grade fine slender parboiled varieties are produced. This does not entail the use of steam, the requisite heat being applied to the previously steeped paddy by roasting it, mixed with sand, in large shallow iron pans over a strong fire.

Parboiling results in an increased total outturn of rice as well as reduced breakage in hulling and polishing. It may, however, be remarked the variations in the methods of parboiling practised in this country, the different lengths of time during which paddy is steeped and heated and the varying degrees of efficiency of the equipment employed to convert the paddy into rice, render it impossible to say which is the most efficient system from the point of view of hulling quality. The following extract from a progress report on the scheme of research on 'quality in crops with special reference to rice' may be of interest:

"Parboiling invariably improves the milling quality of raw rice. But the milling quality varies largely between different treatments of parboiling. The different varieties of rice also respond very differently on parboiling in regard to milling quality. Longer periods of soaking (48-72 hours) together with steaming at 15 lbs. for 15 minutes gave uniformly better results with all the varieties studied. Steaming for longer periods results in greater breakages."

Raw And Parboiled

The precise nature of the demand for raw and parboiled qualities is difficult to analyse owing partly to the complexities of consumer preference and partly to the widely varying economic and social conditions which prevail throughout the country. Likes and dislikes of rice eaters are strongly defind and no cogent reasons could be given by consumers to account for their tastes. The variety of rice to which consumers become accustomed agrees with them. Since the majority of consumers are rice growers themselves, the natural tendency is for the local varieties, regardless of their quality, to be used and preferred for all edible purposes.

The results of certain studies on quality in rice with reference to the chemical composition of different types of rice which have been carried out at the Indian Institute of Science, Bangalore, seem to have clearly established the following main facts:

(i) Parboiled rice in an unpolished or moderately polished state is very similar in composition to the corresponding variety of raw or untreated rice.

(ii) A number of commercial samples raw and parboiled milled rice collected in South India have shown on analysis, that the parboiled varieties are somewhat richer in protein and minerals than raw milled rice. This is stated to be due possibly to the lesser degree of polishing given to the parboiled type.

(iii) Storage experiments to determine the keeping quality of raw and parboiled rice have also demonstrated the superiority of the parboiled variety.

(iv) During the course of preparation for cooking, it is normally the custom to wash the rice in one or more changes of fresh water. Parboiled rice, even on being repeatedly washed, lost less nitrogen or phosphorus than raw rice polished to the same extent. Less water-soluble constituents are passed out of parboiled rice on being cooked than raw rice.

With regard to the relative nutritive values of raw and parboiled rice, investigations have shown that a large proportion of vitamin B (1) (thiamine), proteins and other nutrient substances (minerals) contained in the aluerone layer and the embryo is lost during the course of milling in the case of raw rice. In parboiling, however, these water soluble nutrient substances infiltrate into the interior of the grain and are not lost on subsequent milling. Therefore, the parboiled rice is richer than the raw rice.

Parboiled rice stores better than raw rice in the uncooked state and, when cooked, it retains its freshness for a longer period than raw rice especially when kept steeped in water. Parboiled rice does not turn sour and is, in fact, quite palatable after 35 hours keeping, particularly if heated up. It is significant that, where conditions of labour are such as to preclude cooking more than once a day, as, for example, in the tea gardens and rubber plantations, parboiled rice is favoured on account of its characteristic feature of keeping well.

2

Machine-milled and Hand-pounded

The nutritional superiority of lightly or under-milled rice has, in recent years, led the Governments to encourage the use of under-milled or hand-pounded rice. For instance, as early as 1939, the Government of Mysore sponsored a company designed to produce and market hand-pounded rice in the State. The suggestion

was even made that mills should be allowed to turn out only very lightly milled rice or, in the alternative, be compelled to close down. This suggestion was widely implemented during the war period when restrictions on the polishing of rice were imposed by several Governments like those of Madras and Bombay and instruction given for under-milling when granting licence to mills. Handpounding and under-milling also resulted in higher yield of rice. Thus, there was a gain in quantity in addition to that in nutrition.

It is noteworthy that 60 to 65 per cent of the rice produced and consumed in India is handpounded, very largely by the growers themselves. But it has also to be noted that 87 per cent of the milled rice is put on the market as against only 26 per cent of the handpounded rice. From the marketing point of view, therefore, milled rice unfortunately occupies quite an important position.

In spite of the fact that so large a proportion of the rice consumed in India is handpounded the tendency for a number of years past has been for machine milling to increase. The number of large rice mills had increased by over 100 per cent, i.e, from about 500 to over 1,000 between the years 1921 to 1937; in Bengal the number had risen from 202 to 351, in Bihar and Orissa form 13 to 99, in Madhya Pradesh from nil to 44 and in Madras 173 to 404, in the same period.

The progress since 1937 has not been as rapid. In 1944, according to the publication "Large Industrial Establishments in India," the number of mills in India was less then 1,250 while in 1937 it was 1,000. In Bengal the number had fallen from 351 to 326. In Madras, it had risen from 404 to 510. In Madhya Pradesh, it went up from 44 to 67. The number of registered rice factories was 1,554 for the Indian Union according to the First Census of Manufacturers, 1946. Not all the mills of which records are given

in the "Large Industrial Establishments in India" work all through the year. A number are closed for various reasons, some for the whole season and others for long or short periods. The small oil-driven mills are often equipped with one or, possibly, two hullers and have a limited output only. Many operate for a few months in the year when paddy arrivals are sufficiently large to enable them to work. An outstading fact about the mills is that they are not working at full capacity. The main reason, as has already been pointed out, is that 60 to 65 per cent of the paddy produced in the country is handpounded. In spite of the appearance of small huller mills in rural areas, the majority of rice growers and agricultural labourers still eat handpounded rice. Moreover, handpounded rice is beginning to find increasing favour among the educated and professional classes, particularly in South India. The Government of India, too, discourages the establishment of any more mills and it recommended to the State Governments, as early as 1950, that licences may not be issued to start new mills, small or big. The Rice Milling Committee appointed by the Government of India in its report advocated the total elimination of all huller mills (1955). The Second Five-Year Plan has ruled out any addition to existing mills. All may be attributed to the steady growth in the consumer-preference to handpounded rice as a result of the recognition of its superior qualities. This growing preference for hand-pounded rice, is, in no small measure, due to the sustained efforts of the All India Khadi and Village Industries Board.

Coloured Rice

There is a tendency to link coloured rice with parboiled rice or the maturity of the grain. Clear distinction must be made, therefore, between the rice artificially coloured by the external application of colouring matter which may be removed by washing and rice which has colour induced into the kernel itself by means of variation in the normal process

of parboiling the paddy prior to husking or milling. The demand for the former is confined mainly to few areas, principally, in the South of India. These areas are Districts of Kurnool, Bellary, Anantpur, and Cuddapah, Hyderabad and Bombay City. Coloured rice is also available for sale in a number of markets all over the country but the demand outside the regions mentioned here is strictly limited. It is significant that artificial colouring is given only to commercial raw varieties intended for sale. The rice retained in villages does not receive this treatment. It is also significant that parboiled rice is not given an external coating of artificial colour although a yellowish tinge may be imparted to it by extending the time of the parboilding process by a few minutes. Such rice is in vogue only in West Bengal, Orissa, and in parts of Bihar and Assam. Many of who emigrated from these States, prefer yellow tinged parboiled rice of the quality known as Durban quality.

The demand for yellow, parboiled rice is rigidly confined to North-eastern India. In other parts of the country and especially in Northern, Western, and Central India, where whiteness is an important quality factor, rice of this type would be regarded as hardly fit for human consumption, even by the poorest. The precise reasons for the colouring of rice and how the demand originated is not known. Thus, it is debatable whether the incentive to colour rice first came from consumers or from suppliers. There seems, at all events, to be no special religious significance attaching to the use of coloured rice. However, those familiar with the rice trade and the quality factors of rice, will not be at a loss for a reasonable explanation. It is well-known, for example, that colour reflects the age or maturity of rice and especially of the varieties which possess some degree of translucency. The difference in colour between a rice several months or a year old and that newly harvested is difficult to describe and is not noticeable in individual grains so much as

in the bulk. As old, matured rice is preferred and is more costly than newly harvested produce, the simple expedient of colouring makes new rice look like old. It is true that, where an external coating of colour is given, the colouring matter comes off in the invariable washing process to which rice is subjected prior to cooking, but after contact with water it is not possible to distinguish between new and old rice. Similarly, damaged or defective rice can be effectively disguised by the external application of colouring matter.

The Value Of By-Products

In the small mills, husking and polishing are carried out in one process and the millings consist of a mixture of husk and bran. The fuel value of this mixed product is low and it is often thrown away, the demand being small. It is also of very low value as cattle food, though sometimes used for this purpose. Veterinary Officers are of the opinion that a mixture of husk and bran may cause serious digestive disturbances in cattle, as indeed is to be expected from the nature of the husk.

In villages in which the practice of pounding persists, the husk is often used as fuel and any bran removed on pounding may be used to make cakes for human consumption or as cattle food. The loss of those by-products must be considered one of the disadvantages involved by the spread of small rice mills.

3

Rice Milling

Two main types of rice milling machinery are used in India. The first is the simple and comparatively cheap horizontal huller of small size and the second, the more complicated plant, known as the self-contained or automatic sheller in which, briefly, the paddy is sieved and hulled, the products of hulling being automatically separated into husk, whole rice, brokens and bran and the resulting rice finally polished in a pearling cone.

The fundamental principle hulling of paddy (and the polishi g of rice) is friction. when machinery is employed, one surface revolving within and against another stationary rurfece. The simplest form of huller consitts of two cylinders fixed side by side on a shaft which is capable of being revolved at high speed within an outer casi g. Both cylinders are grooved, one in such a way a to receive the paddy and the other to dis-Charge it after the husk been removed. The actual husking is effected by a steel blade set in the outer casing against which the cylinders revolve. The position of the blade is capable of adjustment in order to accommodate different kinds of paddy and to give different degrees of hulling.

Hullers

Hullers usually work in batteries of two to four, but single hullers are often found in rural areas. The first operation is designed merely to remove the husk and to achieve this, a fine or close adjustment is not advisable as it would result in the grain breaking up badly. The paddy is poured into a hopper the mouth of which is attached to an opening on the top of the outer casing of the huller into which the paddy flows. The friction applied to the paddy by the revolving cylinders against the huller blade cracks the husk and remove it. In the bottom of the outer casing, there is an outlet through which the husked rice is ejected to gether with husk, some uneusked grains, broken grains and bran. The mixture is, sometimes, sieved to remove some of the unhushed grains, the brokens and bran and may be passed through another exactly similar huller, but with a different huller blade setting. This carries the process a stage further by removing some or all the pericarp which is the thin coating of the rice kernel itself. The husk from the previous hulling which is passed into the second huller acts as a "cushiong" or polishing agent. The product which fimally emerges contains while rice mixed with broken grains, bran and very finely

crushed husk, but, more ofter than not, husk is broken up into such small particles by this type of hulling equipment that it is not practicable or worthwhile to try and separate the two products. The mixture has some food value and is often used to feed cattle, donkeys and horses.* This is, sometimes, winnowed to separate the bran and nusk which is disposed of separately. The rice, that remains, contains whole grains and brown grains, of various sizes. Further sifting may be done in order to remove small brokens, but this entirely depends on the miller's choice which is governed by market consideration.

Sometimes three or four hullers are used in a series, to avoid excessive breakage from drastic milling. If the rice kernel is subjected gradunlly to progressive abrasion, it ensures a comparatively large proportion of whole or only slighly broken grains with a fairly good polish. For all practical purposes, therefore, it may be said this type of huller performs the dual function of husking the paddy and imparting polish.

It is interesting to observe that the above type of huller is used to a much greater extent than the more elaborate automatic plant.

A modification of the huller is a huller-*cum*-polisher arrangement in which the polishing equipment is integral with the huller. These are small machines only slightly bulkier than the huller alone.

The handling capacity of the average sized huller, requiring up to 5 horse power to drive it, rangees from about 350 to 500 lbs. of paddy per hour and the pre-war (1939) cost of an

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*It should be noted that the more elaborate milling plant separates the husk completely. This has little or no commercial value and where motive power other than steam is employed for which it would normally be used to fire the bailers, or where parboiling is not practised, paddy huak is generally thrown away.

imported huller of the capacity (without polisher) was about Rs. 650. Locally made hullers, however could be obtained about one-fourth of this price or even less. The price in 1948 of a Bombay made huller, however, was found to have gone up to Rs. 350 i-relation to its pre-war price of about Rs. 175.

The Sheller

The second type of milling machinery works automatically with a minimum of manual labour. The following description may be regarded as applying in principle to all similar plants,

On arrival at the mill, the paddy is first of all, subjected to a series of sievings and winnowings to remove immature grain and the various kinds of extrancous matters (sticks, straws sand stones and lumps or mud) which may have found their way into the produce.

The hulling or "shelling" process comes next, its purpose being to remove the husk from the kernel. The hullers consist of two discs of cast iron, rough coated on their inner surfaces generally with a composition of emery and cement. The lower disc is fitted on to a vertical spindle and can be made to revolve at wnatever speed is required, whilst the upper disc is stationary. The paddy is fed through a hole in the stationary upper disc and entering the space between this disc and the revolving one below, its jusk is cracked and removed.

To secure the maximum efficiency, a good deal of skill is required in the setting of these discs. At no time is 100 per cent efficiency possible owing to differences in the size and shape of of the grains dealt with. A huller set to deal with the "average" grain of the consigament must inevitably pass throuah it. A percentage of small grains which are larger than the average are broken or may have the cubicle and some part of the kernel removed as well as the husk. The products of hulling are, in consequence, a mixture of husk, husked rice together with some unhusked grains, broken grain and bran.

Winnowing machines or forced draught rotaries separate out the husk. Further winnowing and sieving separate the whole grain (shelled and unshelled) and the larger brokens from the smaller brokens and the bran. The bran from the hullers is sold for cattle feed, but the husk is not of much commercial value.

The shelled and unshelled whole grain, together with the large brokens, is then pressed on to a "shaker". This consists of a rectangular tray forming a smooth and very slightly inclined plane to which a shaking motion at right angles to the incline can be imparted by means of rockers. The surface of the inclined plane is interrupted by a series of plates which are all set about half an inch above the surface of the tray and arranged to zig-zag step pattern from the top to the bottom of the incline. On the smooth surface of the tray, at points about half way up the incline, the mixture of shelled and unshelled grain is fed. The shaking motion imparted length wise throughout the tray keeps the grains moving on the polished surface, where, by what seems to be a combination of gravity and "slip", aided by the projecting steps, the rough unhusked grain moves up the slope to fall into a waiting receptacle there, whilst the smoother husked grains slide downwards for collection at the bottom of the plane.

The unhusked grain is conveyed back to the hullers, while the husked grain is ready for further processing. This, by removing the enveloping pericarp "skin", is turned into white rice.

Pearling Cone

In preparing white rice, a machine called a 'pearling cone' is used. This consists of an inverted truncated cone of cast iron, having its surface coated with a mixture of emery and cement and revolving on a vertical spindle. Immediately around this truncated cone is rotated at high speeds and the outer covering of the revolving cone and the wire screen, a series of slightly projecting bars of rubber in the wire screen, checking any tendency for the grain to be carried round with the cone and by causing it

to 'bank', ensuring that it shall be acted on by the rubbing surfaces. Adjustments of the space between the cone and the surrounding wire screen are generated in the pearling process and, in order to reduce breakage, it is usual to pass the grains through a series of pearling cones in each of which a small part only of the abrading is done.

Pearling is the limit to which processing is normally carried out in India. Where a demand exists for a highly processed rice, the procedure is similar in principle to pearling, but less drastic, the cement and emery coated cone being here replaced by drums covered with less abrasive material (sheep skin is the most popular) and the surrounding mean being of finer wire. Oil of tale may also be introduced during the process to add to the lustre of the grain.

The self-contained rice mill is a more expensive plant than the simple huller. A typical installation manufactured in India and capable of handling 2,200 to 2,800 lbs. of paddy per hour was early in 1939 priced at Rs. 10,625 and a large plant with a capacity up to 3,800 lbs. of paddy per hour was quoted at roughly Rs. 14,455. About 21 B.H.P. is required to drive the former and 31 B.H.P for the latter. These costs have doubtless increased and in 1947-48 were reported to be about three times as high as those prevailing in 1939-40. Thus, for instance, the price of the Mysore Type Self-contained Rice Mill No. 9, with a capacity of 3,200 to 3,900 lbs. of paddy per hour, and requiring B.H.P. of 30-36, had risen from Rs. 12,000 in 1939-40 to Rs. 18,500 in 1941-42, Rs. 31,500 in 1943-44 and Rs. 37,000 in 1947-48. These prices were for railway transit.

In spite of the relatively high initial cost, the self-contained rice milling plant is achieving increasing popularity mainly in Madhya Pradesh, Bombay and parts of Peninsular India.

Until comparatively, recently, foreign manufacturers practically monopolised the sale of these plants in India. However

more than one Indian firm has successfully entered this field. The firms concerned are located mainly in the Bombay State.

5

Implements of Handpounding

There are a number of implements used in different parts of India for handpounding of rice. They are pestle and mortar, wooden chakki, stone chakki, clay chakki and dhenki.

Generally wooden, stone and clay chakkis are used only for dehusking paddy, while pestle and mortar and dhenki are used for polishing dehusked rice and also for combined process of dehusking and polishing rice.

Dhenki is used mainly in Assam, West Bengal, Orissa, Bihar and in some parts of Madhya Pradesh, Utter Pradesh, Punjab and in Andhra both for dehusking and polishing. Pestle and mortar is mainly used in Madras, Travancore-Cochin, Mysore, Hyderabad and Andhra, both for dehusking and polshing rice.

Stone Chakki

It is generally used in Gujarat. It is made out of soft stone as well as hard stone. It consists of two discs each 2 feet in diameter and 3" in thickness. The discs are placed one upon another and so adjusted with a pair of iron rod and plate that the upper disc can be rotated with a handle when the lower disc remains fixed. At the centre of the upper disc there is an opening of about 7" diameter which receives the paddy when the upper disc is in motion. By the friction between the two discs, the paddy is dehusked and the rice comes out through the gap between the two discs. The gap can be regulated with the help of the iron rod and plate to suit the size of the paddy to be dehusked. The dehusked rice is then polished with a pestle and mortar or dhenki. The stone chakki

can dehusk about 80 to 100 lbs. of paddy per hour, and the percentage of recovery is slightly greater in the stone chakki than in the wooden chakki. Its advantage over the wooden chakki is that it can be worked without any repairs for a year and it lasts for years. This Gujarat chakki is becoming popular and is spreading to other areas. It costs Rs. 40/-

Wooden Chakki

Wooden Chakki, known as Maharashtra Chakki, is found in some parts of Madras, Maharashtra and Andhra. This is a flat wooden grinder about 22" in diameter and about 18" in height. Its working is simple, The output of rice per hour is less than in the stone chakki. Another defect is that the groves in the working surface wear out very quickly, i. e., within a week of continuous work. It becomes useless within a year. It can dehusk 40 to 60 lbs. of paddy in an hour and it costs Rs. 20/-

Clay Chakki

This is used in the rice growing areas of Vindhya Pradesh and some parts of Madhya Pradesh. It lasts only for a short period of 3 to 4 months, after which it becomes useless and is thrown away. Nearly 40 maunds of paddy can be dehusked during the life of the chakki. Chakkis of 16 to 19 inches in diameter are made out of clay which is mixed with fibrous materials. As this chakki has to be completely dry before use, it cannot be prepared in the rainy season. Five to 6 chakkis are, therefore, made in the summer for use throughout the year. It is generally heavy and is worked by two persons at a time, who have to be relieved by another batch after some time. It is thus worked by turns. In a day, with hard labour, only 3 to 4 maunds of paddy can be dehusked. It costs next to nothing. The breakage of rice is very little.

Mazulipatam Chakki

This is an elaborate machine in which the stone chakki described above is worked at a high speed by two toothed pinion arrangement. The handle of the machine is rotated vertically by two men, standing. It is a combined winnowing and husking machine. It can dehusk 20 maunds of paddy in a day of 8 hours, but it is very heavy and exhausts the workers soon. In all, five persons are required for dehusking. For polishing by pestle and mortar, two more persons are required. It costs Rs. 700/-

Pestle and Mortar

This is used both for dehusking paddy and milling (polishing) dehusked rice. It is mainly used in Madras, Travancore-Cochin, Mysore, Hyderabad, Andhra and Coorg. It is also used in other States for milling only.

The mortar is of stone or wood with a hole of about 8" deep and 6" in diameter. The pastle is of heavy wood ranging from 4' to 6' in length with an iron hub at one end and a ring at the other so that it is used for dehusking and polishing as required. In this method, paddy is paced in the mortar and pounded with one or two pestles handled by women. Two women can dehusk and mill ¾ to 1 maund of paddy in a day. It costs Rs. 10/-

Dhenki

Dhenki is in vogue in Assam, West Bengal, Bihar, Orissa and in some parts of Uttar Pradesh, Madhya Pradesh, Andhra and Punjab States. It serves both the purposes of dehusking and milling (polishing). The dhenki consists of a wooden beam working on the see - saw principle fixed to a pivot. To one end of the beam is fixed a short pestle and this drops into a wooden mortar fixed in the ground. The mortar is filled with the paddy and the worker treads on the end of the beam

opposite to the one to which the pestle is fixed and thus lifts the pestle two or three feet above the mortar. By suddenly releasing the pressure on the beam, the pestle drops with force into the mortar and husks the paddy contained in it. It can do hulling and polishing by a single process. Normally two to three women are needed to operate a dhenki, one or to working on the beam and the other stirring paddy in the mortar and win-nowing husk, while the pounding is in progress. In a day of 8 hours about $1\frac{1}{8}$ maunds of paddy can be dehusked and milled. It mills 5 Mds. of dehusked rice in a day. Its cost varies from Rs. 30 to Rs. 50 according to size and place.

The following extracts from a note about an improved model of the dhenki issued by two professors of the Cotton College, Gauhati, Assam, who have experimented upon the dhenki, may be found interesting :

"The idea of a centre of oscillation in connection with a heavy body rotating about a horizontal axis is as old as Mersonac (1646). As the dhenki swings round the axle, it dynamically behaves as though, instead of a disributed mass as is actually the case, it had a certain mass collected at a parti-cular point called, the centre of oscillation. The coincidence of the centre of oscillation with the centre of percussion was correctly established by Muyghene (1673). The peculiar property of this centre or percussion is that, if the heavy body be given a shock at this point, there is absolutely no reaction on the axle. The impact of the dhenki with the paddy must take place at this point. In other words, the pestle must be fitted to the dhenki at the centre of percussion. This would avoid unnecessary jerks, elastic vibrations, noises and a wastage of enrgy that invariably would go with these.

The improvement has not only increased the efficiency of the machine, but the yield of rice per maund of paddy is

a lot higher than that of the old dhenkis. The higher yield is due to the removal of the unwanted jerks which formerly broke the grains into unusable bits.

Dimensions of the dhenki

Weight	..	30 seers
Length	..	9 feet
Breadth	..	4 inches
Depth at the pedal end	..	$2\frac{1}{2}$,,
Depth at the far end	..	5 ,,
Distance of axle from the pedal end	..	2'–6 ,,
Distance of pestle from axle	..	5'–$1\frac{1}{2}$,,

This is the model adopted by the All India Khadi and Village Industries Board.

Winnowing fan

Hand Winnowing takes about 30 per cent of the time spent in the process of husking. Time and labour in winnowing can be saved by using a fan that is being worked in some parts of the country where paddy is husked in large quantities. The fan is useful for other grains also.

The construction and working of the fan are simple. Five or six planks are fixed to a cylindrical axle which is made to rotate in a covering made of wood or tin, having only one opening, through which pass both the grain and the husk. The husk is carried away by the wind and the grain, being heavy, falls to the ground. A second chamber may be attached to the main covering in order to check the husk from spreading everywhere. This fan will cost about Rs. 120

The following table gives the working efficiency of the different implements of hand-pounding described above.

Output of Rice in a day of 8 hours

	No. of persons employed	Production in Mds.
Stone chakki	2	From 8 to 10 only dehusking
Wooden chakki	2	From 5 to 6 only dehusking
Clay chakki	2 to 4	,, 3 to 4 ,, ,,
Pestle and mortar	2	$\frac{3}{4}$ to 1 dehusking and milling
Dhenki	2 to 3	,, 1 to $1\frac{1}{2}$,, ,,
	2	,, 5 Only milling
Improved Assam dhenki	2	2 to 5 Dehusking and milling.

CHAPTER VI

RICE IN AMERICA AND PHILIPPINES

1

Experience in America

What has been found true of milled rice in India is also true of the United States of America.

For the purpose of analysis samples were obtained from three mills, two of which used hullers and one cones in the milling process. The samples were inspected before they entered and after they left the following equipment: stone sheller, paddy machine, McGill rubber sheller, first and second break hullers, polisher or brush, trumble, and first and second break cones. The huller samples were of the Zenith (a medium-grain) and Bluebonnet (a long-grain) varieties, and the cone sample was of the Zenith variety. The moisture content of all was 15 per cent. The samples were tested for kernel breakage, germ damage, germ removal, number of cracks, and content of protein, ash and vitamins. The results obtained are as follows:

Stone Shellers

In this machine the hulls are removed from rice to give brown rice. After going through this machine, 11.5 per cent of the kernels in the sample of Bluebonnet rice were broken and 27.8 per cent in the sample of Zenith. Twenty of the Bluebonnet kernels showed germ damage, but there was no increase in the number of cracks. In the Zenith sample, none of the kernels showed cracks, but the number of kernels showing germ damage increased from 0 to 55.

Paddy Machine

This equipment is used to separate the brown rice from the hulls. No increase in kernel breakage or germ demage was found in the Bluebonnet sample after going through the equipment. A small increase (2.1 per cent) in damaged kernels was observed in the Zenith rice. There was no change in the number of cracks, and there was a small increase (of 2) in the number of Zenith kernels with damaged germs.

McGill Rubber Sheller

In this machine the hulls are removed from rough rice, as in the stone sheller. Bluebonnet rice showed a breakage of 6 per cent after going through this shellar, but no change in germ damage. Zenith rice showed a breakage of 9.2 per cent.

First Break Huller

This machine removes the outer layars and part of the inner layer from brown rice. An increase in breakage of 15.5 per cent in Bluebonnet, and of 23.2 per cent in Zenith, was found between samples entering and leaving the machine. The number of Bluebonnet kernels with germ damage increased from 72 to 200. Of these, 23 still showed traces of bran, as indicated by the red colour from the staining. In Zenith, the number of kernels with damaged germs increased from 82 to 200.

Second Break Huller

Some of the inner layers and part of the endosperm are removed in the second break huller. Increased breakage of Bluebonnet kernels was 4.5 per cent, and of Zenith 6.1 percent. In both samples all germs were damaged after going through the machine.

The following Tables illustrate the extent of damage in milling:

Effect of Rice Huller

Breakage and Germ

Type of Machinery and time sample was taken[1]	Size of sample[2]	Whole Kernels	
	Grams	Grams	Per cent
Stone Sheller			
Entering	309.6	309.6	100.0
Leaving	124.5	110.2	88.5
Paddy Machine			
Entering	386.3	350.0	90.6
Leaving	366.2	335.9	91.7
Mc Gill rubber sheller			
Entering	348.0	348.0	100.0
Leaving	163.8	154.0	94.0
First break huller			
Entering	480.5	400.0	83.2
Leaving	428.6	290.0	67.7
Second break huller			
Entering	474.4	372.4	78.5
Leaving	419.2	310.2	74.0
Brush (polisher)			
Entering	407.4	280.3	68.8
Leaving	455.3	340.1	74.7

1. Samples supplied by Walton Rice Mill, Inc., Stuttgart, Ark.
2. Whole and broken kernels.
3. Number in parentheses is number of kernels with total germ removal.
4. This sample is a mixture of brown and rough rice. The data refer to damage
5. Number in parentheses is number of kernel with traces of bran layer.

Milling Machinery on Kernal Damage in Bluebonnet Rice.

Broken Kernels		Cracks	Whole Germ	Damaged Germ
Grams	Per cent		Number in 200 Kernels.	
0	0	1	200	0
14.3	11.5	1	180	20 (10)[3]
36.3	9.4	1	171	29 (22)[3]
30.3	8.3	1	170	30 (22)[3]
0	0	2	172	28 (5)[3 4]
9.8	6.0	0	175	25 (10)[3]
80.5	16.8	0	128	72 (33)[3]
138.4	32.3	0	0	200 (22)[5]
102.0	21.5	2	0	200 (37)[5]
109.0	26.0	2	0	200 (37)[5]
127.1	31.2	3	0	200 (57)[5]
115.2	25.3	2	0	200 (57)[5]

in the brown rice. The rough rice was not damaged.

Effect of Rice Huller

Kernel Breakage and Germ

Type of machinery and time sample was taken[1]	Size of sample[2]	Whole Kernels	
	Grams	Grams	Per cent
Stone Sheller			
Entering	1112.0	1112.0	100.0
Leaving	595.0	430.0	72.2
Paddy Machine			
Entering	1260.0	1015.0	80.5
Leaving	1371.0	1075.0	78.4
Mc Gill rubber sheller			
Entering	941.0	938.0	99.7
Leaving	1327.0	1205.0	90.8
First break huller			
Entering	211.9	171.2	80.8
Leaving	190.8	109.9	57.6
Second break huller			
Entering	218.9	150.4	68.7
Leaving	206.9	129.5	62.6
Brush (polisher)			
Entering	208.8	124.7	59.7
Leaving	213.3	123.3	57.8
Trumble			
Entering	210.1	135.3	64.4
Leaving	221.8	140.4	63.3

1. Samples supplied by the Arkansas Rice Growers Cooperative Association,
2. Whole and broken kernels.
3. Number in parentheses is number of kernels with total germ removed.
4. Number in parentheses is number of kernels with traces of bran layer.

Milling Machinery on Damage in Zenith Rice.

Broken Kernels		Cracks	Whole germ	Damaged Germ
Grams	Per cent		No. in 200 Kernels.	
0	0	0	200	0
165.0	27.8	0	145	55 (33)[3]
245.0	19.5	2	147	53 (25)[3]
296.0	21.6	2	145	55 (28)[3]
3.0	.3	2	150	50 (21)[3]
122.0	9.2	2	150	50 (21)[3]
40.7	19.2	3	118	82 (52)[3]
80.9	42.4	3	0	200 (127)[4]
68.5	31.3	4	91	109 (91)[4]
77.4	37.4	0	0	200 (95)[4]
84.1	40.3	2	0	200 (95)[4]
90.0	42.2	5	0	200 (94)[4]
74.8	35.6	4	0	200 (95)[4]
81.4	36 7	5	0	200 (92)[4]

Stuttgart, Ark.

Brush (or Polisher)

The remaining inner layers and more of the endosperm are removed during polishing in this equipment. No further increase in breakage was found in Bluebonnet kernels. All kernels were chipped, and all the germs had disappeared in both varieties of rice. The Zenith sample showed a small increase of 1.2 percent in kernel breakage after polishing.

Trumble

In this machine the appearnce of the white rice is further improved. Little or no further damage was done to the grains.

Results with cone Equipment :

The cones take the place of the hullers in this equipment. Rice exposed to first break and second break did not show any increased breakage resulting from exposure to this type of machinery.

The sample of rice entering the first break cone had 13 per cent broken kernels, the same percentage of broken was found in the sample leaving this equipment. A similar observation was made in the samples from the second break cone. The number of cracks also remained unachanged.

Kernels with germ damage increased from 83 to 185 after going through the first break cone, and remained the same in the second break cone. The cones were less severe than the break hullers on the rice kernels, since 11 out of the 200 kernels showed a completely non-damage germ after going through first and second cones,

TABLE

Effect of Rice Cone Milling Machinery on breakage and Germ Damage in Zenith Rice

Type of machinery and time sample was taken.[1]	Size of sample[2]	Whole Kernels		Broken Kernels		Cracks	Whole germ	Damaged germ
	grams	grams	percent	grams	percent	No. in 200 Kernels		
First break cone;								
Entering	1390.0	1210.0	87.0	180.0	13.0	1	117	83 (38)[3]
Leaving	1316.0	1144.0	87.0	172.0	13.0	1	15	185 (139)[3]
Second break cone								
Entering	1496.0	1232.0	82.4	264.0	17.6	0	11	189 (137)[3]
Leaving	1378.0	1156.0	83.9	222.0	16.1	0	11	189 (146)[3]

1. Samples supplied by Rickert Wessanen and Laan, Inc., New Orleans, La.
2. Whole and broken kernels.
3. Number in parentheses is mumber of kernels with total germ removed.

The following Table summarises the results from the milling tests. It will be observed that the stone sheller and the first and second break hullers were responsible for most of the large breakage and germ damage resulting from milling. All germs were removed from rice which had passed through the first break huller. Cone machinery did not cause additional breakage, but did cause considerable germ damage.

Summary of Kernel Breakage and Germ Damage Occurring During Rice Milling

Machinery	Kernel breakage		Germ damage	
	Long grain	Medium	Long grain	Medium
	Per cent		Per cent	
Stone sheller	11.5	27.8	10.0	27.5
Paddy machine	0.0	2.1	0.5	1.0
McGill rubber sheller	6.0	9.0	0.0	0.0
First break huller	15.5	23.2	64.0	59.0
Second break huller	4.5	6.0	...[1]	55.5
Brush (polisher)	0.0	1.9	...[1]	...[1]
Trumbles	...[2]	1.1	...[2]	...[1]
First break cone	...[2]	0.0	...[2]	51.0
Second break cone	...[2]	0.0	...[2]	0.0

1. Since all germs were already damaged in all kernals which entered this equipment, this study does not reveal to extent the what equipment causes germ damage
2. Not tested.

2

Rice Enrichment

The policy of enriching wheat flour of low extraction with certain nutrients, successfully adopted in the United States of America, has focussed attention on the possibility of a parallel procedure in the case of rice. The prevalence of *beri-beri* and

other vitamin deficiency diseases in rice eating areas indicates the need for a greater intake of certain vitamins. It is clear, however, that the enrichment of rice is technically more difficult than the enrichment of white wheat flour. Synthetic vitamins can be mixed homegeneously into a flour, but rice is eaten in the form of uncrushed grains. Moreover, rice unlike wheat, is usually washed before being coocked,

Methods of solving at least some of the technical problems involved in rice enrichment have been devised. The aim of rice enrichment is to add nutrients to milled rice so as to give the resulting product a nutrient content which is considered desirable on public health grounds, for example, a nutrient content equivalent to that of husked rice. Two methods of enrichment have been reported. In both, enrichment involves two steps :

(a) preparing a fortified *premix*, and

(b) diluting the *premix* with ordinary white milled rice in a subsequent process.

The first method was worked out in the laboratories of Messrs. Hoffmann LaRoche. The *premix* consists of ordinary white milled rice which is impregnated with a concentrated solution of the vitamins and/or minerals chosen for enrichment. The impregnated grains are then coated with film-forming edible substances. This coat protects the vitamins against deterioration and prevents substantial losses during the washing prior to cooking.

The final enriched products is prepared by blending the *premix*, for the conversion rice differs in appearance from ordinary white rice, if thiamine, niacin, and iron in the form of pyro-phosphate are the nutrients added to the *premix*. The addition of reboflavin which has a strong yellow colour, changes the colour of the permix sufficienely to make the impregnated grains visible in the blend.

Fortification of the *premix* with 1 mg. of thiamine and 13 mg. of niacin per gram, and the blending of the premix with milled rice in the proportion of 1 to 200, yield a final product with a vitamin content equivalent to, or somewhat higher than, that of husked rice. Enriched rice so prepared contains 5 micro-grams of thiamine and 65 micro-grams of niacin per gram. The cost of these vitamins, the costing ingredients, the manufacture of the *premix*, and the blending of the *premix* with white rice is estimated not to exceed 25 cents per kilogram of enriched rice (equivalent to an increase of 1.7 per cent in the cost of rice, calculated on the basis of a wholesale price of 15 cents per kilogram).

Tests have shown that, by the use of the advocated mixing method, the *premix* is homogeneously distributed throughout the finished eniched rice. Flavour and cooking quality are not affected by the enrichment procedure. It is claimed that the househeld washing of enriched rice prior to cooking will not remove more than 3 to 5 per cent of the added vitamins. Storage of the *premix* rice for one year at room tempreature in the United States of America did not result in loss of the thiamine and niacin added. After storage for three weeks at 45°C, a loss of only 3 per cent of thiamine and no loss of niacin were observed.

In the second method of artificial enrichment, developed by E.A. Tieger, white rice grains are impregnated with a solution of vitamins in water (Thiamine, Niacin and highly soluble salt, primary sodium phosphate). The rice is dried and coated with a thin collodian membrane. This protects the vitamins from extraction during washing, but when the rice is cooking, the vitamins diffuse into the cooking water, since the film is removed by hot water. The enriched rice is prepared in a concentrated solution of vitamins, and subsequently diluted with un-enriched white rice in the proportion of 1 : 100,

The following considerations in support of enrichment are put forward by Nik and Williams;

One might consider 1 milligram thamine per day per capits a reasonable minimum provision....if the utmost economy were necessary. This would correspond roughly to 1 milligram per pound of rice where the rice consumption is high (365 pounds per capita).

"An economic advantage of such artificial enrichment over any form of parboiling is that only 1 to 2 percent of the rice requires special processing. Where weather conditions permit prompt and satisfactory sun drying of parboiled rice, this should not be costly. However, when artificial drying must be resorted to, either constantly or intermittently with changes of weather, drying costs may equal or exceed the cost of fortifying ingredients. On the other hand, if parboiling saves a large amount of breakage and if, under Oriental conditions, such breakage results in serious loss of saleability, the advantage may lie with parboiling. The perils of inadequate or improper drying under tropical conditions also need careful evaluation".

The importance of eradicating *beri beri* has been emphasized throughout this survey. It seems highly probable the introduction of enriched rice would be an effective means of preventing this disease in certain areas in which it is highly prevalent, and particularly in urban areas.

Enrichment has, however, certain disadvantages when considered as a means of improving the nutrition of rice caters on a wide scale. A number of practical problems wou'd have to be solved in arranging for the preparation and distribution of enriched rice. The blending of the *premix* with the milled rice must take place either at the mill or in depots where rice is stored, and the process must be inspected and effectively controlled. This may be feasible where there are large mills and the

rice industry is well orgrnized generally, but where rice mills are many and amall, and rice dealers and stores are numerous, the introduction of enrichment will present formidable difficulties. These will be accentuated in rural areas where mills are scattered. In the considerable areas where home-pounded rice is still generally eaten and the producer usually consumes his own rice, enrichment would be impossible ; but since home -pounded rice is not impoverished of vitamins to the same extent as milled rice, it would be less necessary. The small producer may, however, take his rice to the local mill and have it milled for consumption by himself and his family. A considerable organisational effort would be needed to ensure that rice was enriched under such circumstances.

In the enrichment procedure at its present stage of development only thiamine, niacin, and iron are added. The addition of riboflavin gives the *premix* a strong yellow colour which remains visible after blending and cooking. A grain mixture containing strongly coloured grains in the proportion of 1:200 might be even less appealing to the purchaser and consumer, than under-milled or parboiled rice. Riboflavin deficiency is, however, common in rice-eating areas. Apart from riboflavin, typical rice diets have other defects which will not be corrected by the use of enriched rice as at present prepared. These include deficiency of other vitimins in the B_2 group. With regard to the enrichment of wheat flour, it has been remarked that there is good reason to think that where measurable factors of the vitamins of B_2 complex are deficient, other factors which are not measurable and some which remain unknown, will be deficient too. Since some at least are known, to be important for health, a policy of enrichement of white flour with only the B_2 group of vitamins must be regarded as unsatisfactory".

Recent research has shown that deficiency of pantothenic acid is concerned in the causation of the "burning-feet", syndro-

mes, and further investigation may indicate the importance of lack of other vitamins in the B_2 complex in rice-eating areas. Again, calcium deficiency is among the most important defects of typical rice diets and enrichment according to existing procedures does not make good this deficiency.

The greater part of the "poor rice diet" consists of rice; the rest of the diet is not ususlly rice in foods of high nutritive value. While rice of any kind is a poor source of riboflavin it is probable that a rice diet based on home-pounded, undermilled, or parboiled milled rice is superior, at least in certain respects to a similar diet based on enriched rice. Further investigation of this subject is needed. There is some evidence that the intake of relatively large amounts of certain food factors may sccentuate deficiencies of others. Thus, it was observed in Japanese prison camps, after the war, that the treatment of pellagra with large doses of niacin tended to precipitate the appearance of *beri beri.* It seems unlikely that enrichment as described above would involve dangers of this nature, but the possibility should be borne in mind.

Finally, it should be pointed out that synthetic vitamins are not at present manufactured in the rice-eating countries of the world. There is no esssential reason why they should not be, though manufacture might be difficult in certain countries at their present stage of technical develoyment. Meanwhile, however, they must be obtained from abroad. During the war, supplies of cod liver oil and vitamin concentrates of East Asian countries were reduced or put off both because of shortage of total world supplies and because of transport difficulties. To expect, the recurrence of such interruptions to international trade would be pessimistic. It is, however, worth noting that, as things are, the adoption of a policy of rice enrichment in the rice–eating regions involves dependence on supplies of vitamins from distant parts of the world.

The Baguio Nutrition Committee expressed the view that rice enrichment is likely to prove particularly useful in areas in which *beri beri* is an important public health problem, but that it should in generel be regarded as an expedient which does not remove the need for the improvement of rice diets in other ways. It stressed the fact that enriched rice, as now prepared, does not provide additional amounts of nutrients much needed by rice eaters. It hoped that the results of any field experiments with enriched rice would be carefully recorded for the benefit of all rice-eating countries.

Such an experiment is now in progress in the Bataan province in the Philippines. It has been estimated that in this province some 80,000 cases of *beri-beri* occur annually and that in certain districts 7 to 9 per cent of the population may be affected. The disease is more common in the villages in the province than in towns.

The Nutrition Committee of the Food and Agricultural Organisation of the United Nations at their meeting held in February 1948, at Baguio, Philippines, suggested a thiamine content of 1.8 microgrammes per grame of whole rice. Later it was found that it was difficult to stick to this level as there were many difficulties experienced in the milling process. The Committee, therefore, recommended that a thiamine content of 1.5 microgrammes of thiamine per gram of milled rice be accepted as a minimum with the proviso that, when improved milling and processing of rice permit, the higher level may be adopted. Taking into consideration all the factors, it is considered that the thiamine content must be the index of the nutritional quality of rice.

The Indian council of Medical Research has recently undertaken study of the vitamin contents of pure breed of strains of cereals and pulses in the country and from the data so far available it is found that the thyamine content of husked rice of different varieties varies considerably from 2.2 to 4.5 microgrammes per gram. In the process of milling there is a

considerable loss of thiamine. If the retention of 1.8 microgrammes per gram could be expected in the grain of a variety which is rich in thiamine, i. e, about 4.5 microgrammes per gram, it is evident that the variety which is low in its thiamine content (2.2 microgramme could not be expected to retain 1.8 microgrammes per gram of thiamine after it is miilled.

RICE LEGISLATION IN PHILIPPINES

The legislative steps taken in the Philippines are significant. An enactment on this subject says: By authority of the United States, be it enacted by the Philippines Legislature, that :

Section: 1:

Polished rice, for the purposes of this Act, shall embrace every kind of rice from which the pericarp and subcortical, or other layers have been removed, and when shows upon analysis less than four-tenths of one per cent of phosphorus pentoxide (P_2O_5).

Section 2 :

There shall be levied, collected, and paid, on all polished rice within the Philippine Islands, at the time of its removel from the building or establishment where the operation of polishing is performed, an Internal Revenue Tax at the rate of five centavos on each kilogram : PROVIDED that the tax imposed in this section shall not be collected on rice polished in the Philippine Islands and withdrawn from the building or establishment wherein it was polished for export to any point outside of the Philippine Islands, if such rice is actually so exported, and proof of exportation sumbitted to the Collector of Internal Revenue in such form and within such time as he may by regulation prescribe.

Section 3 :

There shall be levied, collected, and paid upon all polished rice imported into the Philippine Islands, from the United States or foreign countries, in addition to the import duties imposed (if any), an Internal Revenue Tax at the rate of five centavos per

kilogram. This tax shall be paid to the Collector of Internal Revenue, or his duly authorized representative, by the owner or importer of such rice, while the same is in the custody of the proper Customs Officer, and such rice shall not pass out of the custody of said Customs Officer until the tax shall have been so paid.

Sectton 4:

All the provisions of Act Numbered Eleven Hundred and Eighty-nine, entitled "The Internal Revenue Law of 1904", as amended, regarding the time and manner of collection, and manner of accounting for the specific tax imposed by the provisions of said Act on distilled spirits, fermented liquors, and tobacco products, and all the provisions of said Act, and the regulations issued thereunder, applicable to manufacture of such articles, shall apply to importers and manufacturers of polished rice.

Section 5:

The Collector of Internal Revenue shall issue such rules and regulations as may be necessary to carry into effect the provisions of this Act, and are not in conflict therewith; and such regulations, when approved by the Secretary of Finance and Justice. shall have the force and effect of Law.

Section 6

Any persons violating any of the provisions of this Act or of any lawful regulation issued thereunder, shall be punished by a fine of not less than one hundred pesos nor more then thousand pesos, or by imprisonment for a period of not less than one month, nor more than five years, or by both such fine and imprisonment, in the discretion of the Court.

Section 7:

The Collector of Internal Revenue, with the approval of the Secretary of Finance and Justice, may compromise any civil or other case arising under the provisions of this section, instead of commencing or prosecuting suit thereon, and with the consent of the Secretary of Finance and Justice, he may compromise such case if action has been begun thereon.

CHAPTER VII

SOCIOLOGICAL ASPECTS

The Nutrition Advisory Committee, at its 1937 meeting, recommended certain investigations of the milling problem. The chief points put forward for study were the following :

(a) To what extent has the habit of consuming milled rice spread in India.

(b) Is the apparent tendency to adopt this habit likely to increase ?

(c) If it is actually the case that more and more people are eating machine-milled in preference to handpounded rice, what are the factors under-lying the change in habit ?

(d) Is it possible or desirable to reverse the present tendency ? If so, what steps can be taken ?

The inquiry covered all the principal rice-eating areas in the Madras Presidency, but was not extended to other parts of India. A questionnaire issued by the Committee elicited the information that there was general agreement that the custom of using machine-milled rice is spreading in both rural and urban areas; in only a few replies it was stated that the habit of consuming home-pounded rice had been largely retained, and these were from somewhat remote rural areas. The Marketing Officer, Madras, estimated that about 60 per cent of the rice produced is machine-milled and in general this figure seems to correspond with observation and experience. About one-fifth of the rice consumed in the province is imported and this rice is all machine milled. Taking the available data into consideration, in 1939

about 70 per cent of the rice-eating population of the Madras Presidency consumed machine-milled rice.

The decline in the use of handpounded rice affects all communities. The information received was almost unanimous on this point. Where the use of mills and milled rice has been fully established, all castes and communities have taken to the milled product.

The conclusion may be drawn that in South India the substitution of milled for home-pounded rice has proceeded far. It is obviously important in any campaign to encourage the use of the latter that this fact should be realized. It is not a question of checking a process in its initial stages, but of changing a habit which has been growing. The reasons for this is the multiplication of rice mills, which have appeared even in areas remote from large towns. It is difficult to give exact figures showing the increase in the number of mills. Large rice mills, including concerns dealing with ground-nut oil, and other products in addition to rice, are registered under the Indian Factories Act as 'Large Industrial Establishment'. The number of these does not appear to have grown between 1931 and 1937, as the following figures indicate :

Year		No. of mills registered under the Factories Act
1931	..	559
1932	..	538
1933	..	566
1934	..	583
1935	..	530
1936	..	587
1937	..	554

The total number of large and small rice mills in 1935-36, according to a census taken by the Marketing Officer, Madras, was 3,569 so that those coming under the Factories Act do not form a large proportion of the total. It is the spread of the small mills, often worked by a group of 5 individuals or less, which has done the damage. The usual type of machine employed in the small mills is based on the 'Egnleberg Huller and Polisher' (originally an American production, which has been copied and modified in Indian foundries. Such mills can be found in villages with populations of 2,000 or less.

The extended use of the rice mill is clearly bound up with other social and environmental changes. The development of transport and the improvement of roads enables the paddy grower to bring his grain to the mill. The ubiquitous motor-bus has loosened the bonds which attach the villager to his own plot of ground and traditional manner of life. Cheap electric power is obtainable over wide areas and other sources of power—the steam and the internal combustion engine—are familiar and obtainable. All these factors have played a part in the abandonment of the ancient practice of handpounding.

A myth to which currency is given is that handpounding is primitive, tiresome and time consuming. Investigations were made on the amount of labour involved in pounding a given weight of paddy. These were made in the Tinnelvelly district. Four village women, skilled pounders, were watched at their work and the following records obtained :

Amount of paddy pounded at one time :	2 lbs. 4 oz.
(This amount corresponds to the capacity of the receptacle) Weight of pounder : Number of strokes of pounder 358	6 lb. 14 oz.
Height of stroke : 28 inches :	
Time taken: Average of 4 women $8\frac{1}{2}$ minutes.	

After 100 to 130 strokes the pounder winnowed the grain for about half a minute, the process being repeated 3 times at intervals during the whole operation.

The weight of pounded rice obtained from 2 lbs. 4 oz. was 1 lbs. 8 oz. For a family of 5 persons 6 lbs. to 8 lbs. of pounded rice would be required daily. If reasonable allowance is made for intervals between each spell of pounding, while the stone receptacle is being re-filled, it may roughly be reckoned that one hour's work would suffice to pound enough rice for the daily requirements of an average family. Usually two women pound simultaneously at the same container.

It thus appears that the labour of pounding is not very exacting, though it is monotonous. If each rice-eater pounded his own rice daily, the task would take him less than 10 minutes. It would be a daily routine no more time-consuming or monotonous than shaving. The average villager has plenty of leisure for the task. Why, then, has milling gained in popularity?

Under present conditions it is difficult for the wage-earner or small landholder, however anxious he is to live on home-pounded rice as a staple, to obtain paddy to pound. Various obstacles and difficulties are well described by Dr. Pattabhi Sitaramayya. His report to the Nutrition Committee, which refers in particular to the Godavari and Kistra deltas, says:

" Home-pounded rice means home storage of paddy. Most of the small landholders own not more than two or three acres. They are in debt. What little paddy they grow is sold out in a lump perhaps at the very field itself, in order to meet the liabilities of debt, or some expenditure incurred by social ceremonies, or the purchase of cattle, construction of houses, and so on. In the months of January and February (harvest time) capital expenditure awaits the landholder, which has to be met immediately and can only be met by the sale of paddy. For the time being the householder is able to meet capital expenditure by selling his

paddy and live on credit till the beginning of the next year when again the sale of paddy will enable him to meet existing and future liabilities. In effect, then, the villager has no paddy to pound".

The paddy which the small rice-grower produces may thus become an article of commerce and not be retained as food for his own use. With the money obtained from the same, he buys machine-milled rice which may originate in another part of the province or is imported from Burma or Thailand. It is impossible to estimate the proportion of small cultivators forced to dispose of their grain for the above reasons. It appears, however, that the practice described is common throughout the province.

Other factors which operate against the practice of home-pounding by small-holders, agricultural labourers and industrial workers, says Dr. Pattabhi, are:

"There is no place to store the paddy. There is no capital to purchase paddy or a bazaar where it can be purchased in small quantities. You can go to the bazaar and buy a few pounds of rice. It is very difficult to buy a few pounds of paddy because paddy is sold in large quantities at a time. There is no market where you can purchase your day's needs.

Moreover, to pound paddy you require instruments; a couple of pounders, each costing about Rs. 1-4-0, a sieve costing about 4 annas, and a stone with whole in it planted in the ground .... For home-pounding the height of the house should be 8 feet, clear 5 feet for the persons standing and 3 feet for the pounders to be raised. Most people live in huts or small places and several families are huddled together. Home-pounding implies spacious accommodation, and room for storing the paddy. All these are unobtainable by the ordinary wage labourer".

A point for consideration is the posibility of home-pounded rice becoming a staple article of commerce, widely sold and

consumed. Even at the present time there are agencies which, operating on a small scale, produce handpounded rice for sale, the purchasers being often either progressive members of the community who have been influenced by the propagada of the nutrition workers, or conservatives trying to preserve ancient customs.

The cost both of home pounding and machine milling naturally varies from place to place. The following figures based on information obtained in various parts of the Madras State give a rough idea of the cost involved:

Average cost of machine-milling 100 of lbs. paddy. 0–2–6

Average cost of hand pounding 100 lbs. of paddy. 0–5–6

In general the price of labour necessary to pound a given quantity of paddy is double that demand by a miller for machine-milling a similar quantity. Let us suppose that on the average 100 lbs. of paddy yield 65 lbs. of rice. If the paddy is home-pounded, the weight of the yield is greater than when the same paddy is machine-milled to a high degree. On this reckoning, the labour charges involved in producing 100 lbs. of handpounded rice will be 4 to 5 annas greater than the cost of producing a similar quantity of machine-milled product.

The cost of labour is naturally reflected in the price of the two kinds of rice. One hundred pounds of home-pounded rice usually costs 5 to 8 annas more than 100 lbs. of machine-milled rice. The monthly requirements of an adult man consuming rice as his staple food may be estimated as about 40 lbs. The consumption of home-pounded rice in the place of machine-milled rice will increase monthly expenditure on rice by about 3 annas. For an average family containing 4 consumption units, the extra costs would be about 21 annas per month. This is no small sum in relation to the earnings and incomes of the poorer classes in India.

CHAPTER VIII

RICE MILLING COMMITTEE'S RECOMMENDATIONS

The Government of India appointed the Rice Milling Committee in October 1954. While recognising the necessity of encouraging handpounding of rice, the Government felt the need for an investigation regarding the extent to which hand-pounding of rice could meet the needs of the country and laid down the following terms of reference for the Committee :

1. To examine the working of the different types of rice milling now in vogue in the country from all relevant aspects such as technical, nutritional, consumer preference, economic and employment; and

2. to make recommendations as to the future policy that should be adopted and to indicate the administrative, financial and legislative measures which may be needed on the part Central and State Governments to give effect to them.

The planning Commission in their First Five Year Plan, 1952, devoted considerable attention to this subject and said:

"In the sphere of food processing industries the stage appears to have been reached when further expansion of large-scale industry should not be permitted, except under certain conditions such as for instance, establishments of units by the Government or by co-operative organisations. Rural employment has been affected directly by the growth of privately owned units in this field. For example, in the paddy growing areas, rice pounding was always a substantial source of employment, both whole-time and spare time, especially for women. The recovery

of rice from paddy by hand process was also satisfactory. The introduction of rice mills of the huller type greatly diminished this employment and was also wasteful in various ways. It appears to us that in the interest of rural employment and to ensure better nutrition, the Government should now formulate a programme for replacing the huller type of rice mills by organised handpounding of rice.

> 'Hand-pounding of rice is an important village industry even to this day. It processes about 65 per cent of the paddy, the mills processing the remaining 35 per cent. The programme aims at improving the hand process for increased recovery of rice and production of bran in a pure form by the introduction of paddy husking stone chakkies in place of the pounding method. It is recommended that over a period of 4 years the distribution of about 50,000 chakkies in rice pounding areas might be subsidised. Research is proposed to be carried out for evolving suitable implements for paddy husking such as paddy separator, a better type of chakki which can reduce breakage, etc. It is also proposed that rice mills of the huller type should be gradually eliminated."

The recommendations of the Planning Commission indicated a State Policy of restrictions and control of large-scale industries with a view to a revival of village industries for providing more rural employment. To what extent and on what lines this policy can and should be applied in regard to processing of rice was an important issue for consideration by the committee, India now stands on the threshold of large scale industrialisation; but, under a planned economy, much of the inherent antagonism between large-scale and small-scals industries can be removed if the common production policy recommended by the Planning Commission aiming at a coordination between the two is followed. Mechanised production is efficient in the sense that it produces more in less

time and increases the total value by using more raw materials per unit of manual labour required for handling the machines. But where the supply of raw material is limited and there is a surplus of man-power, mechanisation loses its merit.

In the following extract from a note prepared by the Director of Statistics, West Bengal, in 1954, it has been described how the growth of rice mills in West Bengal displaced the labour originally employded in the handpounding of rice :

> "The rice mills of the mofussil, of course, provided some employment to rural people. But the net result was that thousands of rural people lost their avocation as rice–huskers all over the State. Only a few of them got employment in the rice mills as factory labour. If there was a shortage of man–power in the country making it necessary to release some workers for a national purpose or if there was a surplus of rice which was to be produced as efficiently as possible in order to enable the country to sell it in foreign markets at competitive prices, then only such a process of rationalisation might have some justification from the national point of view. But, as there is actually a surplus of man–power and shortage of rice, the logic of the rationalised process can only be termed as twisted, twisted deliberately by a handful of organised capitalists and labourers for the sole purpose of appropriating the entire value added by this important food industry to themselves, depriving scores of thousands of small producers of their means of livelihood."

The hand-pouning of rice used to be done in the homes of the villagers by women workers along with their domestic duties and they used to retain the bran and a portion of the rice as their wages. This was, therefore, a type of home industry which was part and parcel of the village life of the people, pefectly suited to their food habits and had a great socio–economic

value. Whether the displaced labour will now be available for hand-pounding in areas where rice mills have penetrated, to what extent a revival of handpounding in these areas would be feasible, whether the hand-pounding industry can co-exist with the rice mills, how the price structure of paddy and rice trade will react to a State planned revival of hand-poun-ing on a large-scale in ares where it has already died out or is fast disappearing, were some of the questions which the Commitee had to investigate. In this connection, the Committee had to enquire into the extent of unemployment or under-employment amongst rural labour to whom the handpounding industry was intended to provide employment.

Apart from the question of employment, the Committee also set itself to the investigation of the comparative percentage of recovery of rice from paddy by the different processes of milling, of improvements for saving wastage and breakage, of better handpounding implements easier and simpler to handle and at the same time ensuring better yield, and the ways and means of giving protection to handpounding and putting it on a sounder footing. There was also the more important question of ensuring the retention of nutritive value of rice and pure bran under the different processes of milling.

2

Adverse effects of control

With the advent of Government control of foodgrains in 1942, the rice mills came to play a very important role in the field of procurement all over the country. In those States which adopted the monopoly procurement system, such as Madras, Andhra and Mysore, the rice mills, acting as the main procure-ment agents of the Government, purchased the entire market-able paddy in the villages, and no private sale of paddy or rice was allowed at any stage. The rice mills processed

the paddy thus procured and delivered the resultant rice to the Government for issue as a rationed commodity to consumers. The rice mills were considered as most convenient and efficient agencies for bulk-handling and speedy processing of paddy to feed the large population of urban and industrial areas under rationing. Some States like Bombay and Hyderabad. followed the levy system in Government procurement under which paddy was levied on producers in proportion to the land revenue paid by each or on the acreage held, and collected at the village level. In Bombay, a part of the procured paddy was allotted by the Government for hand-pounding and the balance was processed by the rice mills. In Hyderabad, however, the entire procured paddy was processed by rice mills. In the old Travancore State where State-wide rationing and monoply procurement were in force, mills were not employed for Government procurement as the mills were completely banned. This State, however, produced only about five months' requirements, the rest being met by imported milled rice. The procured paddy was issued as ration in the form of paddy. The State of West Bengal followed a system of voluntary procurement and a partial levy on acreage basis under which the surplus paddy of the large producer was taken over by the Government. Traders were also appointed as direct procurement agents who, on behalf of the Government, purchased paddy in surplus areas which were cordoned off for the purpose. The entire procured paddy was milled by the rice mills. The mills were also allowed to purchase paddy for milling, provided that they sold the entire resultant rice to the Government. Later, the rice mills were allowed to sell one-third of their production in the open market. In Orissa nearly 50 per cent of the exported rice during control was hand-pounded. In Madhya Pradesh 60 per cent of the paddy stocks of dealers and rice mills were procured by the Government and the balance was allowed to be dealt with in the open market.

Under the monopoly procurement system, the rice mills largely monopolised and flourished, with the result that very little paddy was left for handpounding, and the producers, even for home consumption, took recourse to the mills which penetrated into the villages. As a consequence, handpounding received serious setback and practically died out in some States. In the State of Mysore, the Committee was told that only a small percentage of their rice production was hand-pounded. Under the levy system in Bombay, as a result of the Government's patronage, the handpounding industry retained its hold on about 38.5 per cent of the total rice production. The Bombay State, during the period of control, gave further protection to hand-pounding by stopping fresh licences to rice mills and by giving a subsidy. In Hyderabad which followed the levy system of procurement, more than 60 per cent of the total rice production is still handpounded. In West Bengal and Madhya Pradesh where the rice mills played only a partial role in the procurement system and where sufficient stocks were left to be operated in the open market, nearly 70 per cent and 79 per cent respectively of the total rice production are still handpounded.

It will thus appear that during the period of control, in States where open market dealing in paddy were completely prohibited under a monopoly procurement system and where mills were employed as procurement agents, the handpounding industry practically disappeared, but where sufficient stocks of paddy were left to the open market, the hand-pounding industry held its own appreciably, in spite of the existence of rice mills. The handpounding industry was thus pushed out of some States as a result of the then existing special conditions which the government had to meet during the period of control.

Another contributing factor which has placed the handpounding industry at a disadvantage vis-a-vis the rice mills, is

the lack of holding power on the part of the small paddy producer who is compelled to sell out his paddy soon after the harvest, or even before. The bulk of this paddy thus finds its way into the rice mills. In some cases the small producer is often compelled to sell out not only his surplus paddy, but also a part of the paddy required for his own consumption in order to meet his urgent expenses, with the result that he has later on to purchase rice from the market when its price is higher. If rural credit were made available to the producers through a co-operative machinery sponsored by the State, much of their paddy would remain in the villages to be processed by handpounding and be sold as rice, to the producer's best advantage.

It will thus be seen that the case of the handpounding industry is not that of the outmoded handicraft dying a natural death with the advent of the machine. This industry which still has its hold on about 65 per cent of the total rice production of India as a whole, was pushed out of its position during the control days as a result of Governmental measures to meet emergencies and is still being pushed out for lack of rural credit facilities which ought to have been made available to the small producer.

3

Rice milling after decontrol

After decontrol in July, 1954, the Rice Mills Control Order in the States isssued under the Central Supplies (Temporary Powers) Act, ceased to be in force and a licence was no longer required for running rice mills, except in a few States which had already enacted their own independent legislation for the licensing of rice mills. The result has been that in many States a large number of rice mills, especially of the small huller type, have sprung up. Even in Madras State, which had enacted legislation for the licensing of mills, many licences for this type of mills were issued soon after decontrol. In

Travancore area of the Travancore-Cochin State where the State Government, during the period of control, had banned all rice mills, numerous licences for new rice mills have been issued after decontrol. Noticing such development during its enquiry, the Committee requested the Food and Agriculture Ministry to issue immediate instructions to all States to make it compulsory for existing power-driven rice mills to take out licences and to stop issuing licences to new mills, pending the Committee's final recommendations.

During control, the Government made some efforts to restrict over-milling of rice by the mills. The natural tendency in hand-pounding is to under-mill and that of the rice mill to over-mill, the reason being that over-milling by handpounding is laborious and uneconomic, whereas over-milling by the mills requires little extra cost and fetches a higher price. Over-milling means loss of the nutrional content of the rice as well as reduced recovery of rice from paddy. Some of the States such as Bomby and Madhya Pradesh, therefore, issued orders to the rice mills to produce only dehusked rice without any polish. This order proved unpopular and the consumers, as a rule, evaded it by getting their dehusked rice polished by the hullers which caused even greater wastage and loss of nutrition. Subsequently this order was withdrawn and the Government of India, on the recommendation of Shri. Moharikar who conducted a detailed enquiry on this subject, issued instructions to the State Governments to allow milling by the rice mills only upto 3 to 4 per cent removal of bran, which would approach the standard of hand-pounded rice. This order also was not enforced, as it was reported not popular. After decontrol the rice mills have been giving the rice they produce any degree of polish in order to get a higher price.

To sum up: so far as milling is concerned, the immediate effect of decontrol was that those States which so long followed a definite policy of encouraging the Handpounding Industry

and of restricting the production and the degree of milling of rice by rice mills found it difficult to pursue that policy in the absence of a uniform policy in those matters throughout India. The following estimated figures, as reported by the State Governments, will give an indea of the extent of hand pounding in some of the rice producing States after decontrol:

No.	Name of the State	Rice production in (1953–54) '000 tons.	Percentage of handpounded rice
1.	West Bengal	5,224	70.2
2.	Bombay	1,301	38.5
3.	Mysore	436	44.3
4.	Coorg	51	50.0
5.	Madhya Pradesh	2,663	79.1
6.	Andhra	2,135	50.1
7.	Travancore-Cochin	273	69.5
8.	Madras	2,976	8.2*
9.	Hyderabad	581	60.2*
10.	Orissa	2,340	87.2
11.	Assam	1,633	66.0
12.	Uttar Pradesh	2,246	66.0*
13.	Bihar	4,202	97.4

The average percentage of handpounded rice in these rice producing States is 57.4.

*Figures have been worked out on the basis of information supplied by State Governments. In the case of Madras State, however, the Marketing Officer has stated in his evidence that handpounding is 30 per cent. The basis for this statement is not known.

4

Employment Problem

Unemployment of rural labour in India is more of the nature of under-employment because this labour is mainly agricultural. Agricultural operations vary from season to season and from place to place and are sel. dom continuous throughout the year. Generally speaking, in irrigated or wet tracts growing double crops, employment is available for the cultivating labourers inter-

mittently for six to eight months during the year in such agricultural operations as ploughing, hoeing, sowing, transplantation and harvesting. In non-irrigated areas or dry tracts, growing a single crop, they are employed for not more than four months in the year. Where there are subsidiary occupations, construction work in progress, or large-scale industries situated in the rural areas there is more employment for village labour. But large industries situated in rural areas are few. As regards subsidiary occupations, a sample survey conducted by the Ministry of Labour in 1952 revealed the following figures:

Name of State	Percentage of agricultural workers having no subsidiary occupation.
1. Assam	58.6
2. Bihar	73.3
3. Bombay	78.1
4. Madhya Pradesh	82.3
5. Madras	77.9
6. Orissa	71.7
7. Punjab	73.8
8. Uttar Pradesh	78.4
9. West Bengal	87.2
10. Hyderabad	85.8
11. Jammu & Kashmir	62.7
12. Madhya Bharat	77.7
13. Mysore	86.2
14. Pepsu	94.5
15. Rajasthan	89,2
16. Saurashtra	53.6
17. Travancore-Cochin	81.6
18. Ajmer	73.9
19. Bhopal	92.3
20. Bilaspur	50.0
21. Coorg	66.1
22. Delhi	86.0
23. Himachal Pradesh	67.5
24. Kutch	39.9
25. Manipur	66.6
26. Tripura	99.2
27. Vindhya Pradesh	91.7
Average	78.8

These figures show that 78.8 per cent of the agricultural workers in India have no subsidiary occupation. This generally indicates the extent of under-employment of rural labour.

Of rural labour, women form an integral part. The following figures show the working strength of families amongst the agricultural labour population of different zones in India collected by the Sample Survey of the Ministry of Labour :

State.	Average size of family				Working strength of earners			
	Men	Women	Children	Total	Men	Women	Children	Total
1. Assam	1.59	1.43	2.08	5.10	0.97	.20	.02	1.19
2. Bihar	1.74	1.68	2.15	5.57	1.28	.43	.08	1.79
3. Bombay	1.46	1.37	2.21	5.04	0.99	.29	.04	1.32
4. Madhya Pradesh	1.41	1.45	1.90	4.76	1.11	.54	.13	1.78
5. Orissa	1.53	1.56	1.85	4.94	1.16	.30	.06	1.52
6. Madras	1.48	1.53	1.69	4.70	1.18	.66	.07	1.91
7. Punjab	1.91	1.51	2.24	5.66	1.20	.11	.03	1.34
8. Uttar Pradesh	1.70	1.43	1.80	4.93	1.12	.07	.02	1.21
9. West Bengal	1.53	1.45	1.72	4.70	1.12	.16	.03	1.31
10. Hyderabad	1.56	1.47	1.87	4.90	1.22	.59	.10	1.91
11. Jammu & Kashmir	2.13	1.71	2.13	5.97	1.07	.02	—	1.09
12. Madhya Bharat	1.66	1.44	2.13	5.23	1.07	.23	.05	1.35
13. Mysore	1.63	1.46	2.01	5.10	1.15	.49	.05	1.69
14. Pepsu	1.76	1.37	2.20	5.33	1.09	.05	.03	1.17
15. Rajasthan	1.56	1.37	1.99	4.92	1.00	.12	.02	1.14
16. Saurashtra	1.63	1.56	2.36	5.65	1.10	.34	.06	1.50
17. Travancore-Cochin	1.62	1.69	2.11	5.42	1.27	.74	.03	2.04
18. Ajmer	1.56	1.46	1.90	4.92	1.05	.21	.05	1.31
19. Bhopal	1.46	1.37	1.81	4.64	1.15	.59	.17	1.91
20. Bilaspur	1.69	1.15	1.46	4.30	1.27	.07	.02	1.36
21. Coorg	1.32	1.30	1.73	4.35	1.04	.26	.03	1.33
22. Delhi	1.75	1.54	2.36	5.65	1.18	.10	.02	1.30

State	Average size of family				Working strength of earners			
	Men	Women	Children	Total	Men	Women	Children	Total
23. Himachal Prdesh	1.65	1.49	1.79	4.93	1.08	.19	.02	1.29
24. Kutch	1.16	1.43	1.51	4.10	0.81	.34	.02	1.17
25. Manipur	1.34	1.47	1.80	4.61	0.95	.77	Neg.	1.72
26. Tripura	1.63	1.49	1.94	5.06	1.05	.03	01	1.09
27. Vindhya Pradesh	1.52	1.47	2.03	5.02	1.05	.19	.05	1.29
All sample villages	1.60	1.50	1.94	5.04	1.13	.35	.05	1.53

Where the working strength of women earners is high, 0.66 as in Madras, any scheme for rural employment must include occupations which are particularly suited to women and which they can take up as part-time work along with their domestic duties. In some States such as West Bengal, the working strength of women is low (0.16) because even poorer class women are debarred by custom from doing outdoor work for others. In such States it is all the more necessary that, as far as possible, indoor occupations should be found for such women to enable them to contribute to the earnings of the family. It should be noted that under-employment is worst in the States where the working strength of women earners in the agricultural workers' families is lowest, and, therefore, any scheme to relieve agricultural unemployment in these States will be incomplete unless it provides suitable part-time occupations for women. The Planning Commission drew a list of eleven Village Industries, besides Khadi, which may provide employment for rural population on a village level. Handpounding of rice is one of them. The percentage of production of handpounded rice to the total rice production is 79.2 in West Bengal, 38.5 in Bombay, 50 in Coorg, 79.1 in Madhya Pradesh, 69.5 in Travancore-Cochin State, 87.2 in Orissa and 97.4 in Bihar. In some of these States where handpounding is still being done on a considerable scale, the producers handpound paddy mainly

for their home consumption and sell the surplus paddy for being processed by the rice mills. In some States—Bihar, Orissa and Madhya Pradesh—handpounding is done on a large commercial scale and the handpounders purchase paddy from the market and, after handpounding it, sell the rice and make a living out of it. The handpounding industry in these States, therefore, constitutes a major source of subsidiary employment to the producers and cultivating and other labourers during the off-season. This industry particularly suits the domestic life of the rural population, because it is mostly done by the women folk in their homes along with their other domestic occupations. In this country, there are women of the poorer agricultural classes who are not accustomed to do outdoor work except in their own fields, and there are women of lower middle-class who are by custom debarred from doing any outdoor work. For these women handpounding is a suitable source of employment.

For processing 1 maund of rice a day normally 2 women can be employed, each working 8 hours per day on a wage of 10 annas to 1 rupee. Calculated on this basis, if the paddy which is now being processed by rice mills be hand-pounded, it can employ 19.85 lakhs more persons in the following States working for 150 days in the year as indicated below:

Name of State	No. of persons employed in handpounding (in 000)	No. of persons employed in rice mills (in '000)	Additional No. which can be employed if paddy procesed by rice mills is entirely handpounded (in '000)
Andhra	160.7	25.8	383
Assam	161.7	3.1	200
Bihar	613.7	4.2	40
Bombay	75.1	5.4	288
Madhya Pradesh	316.1	4.5	200

Name of Staie	No. of persons employed in handpounding (in ooo)	No. of persons employed in rice mills (in ooo)	Additional No. which can be employed if paddy procesed by rice mills is entirely handpounded (in ooo)
Orissa	306.0	9.0	108
West Bengal	550.3	40.9	560
Hyderabad	80.0	4.4	17
Mysore	3.0	4.5	150
Travancore-Cochin	28.5	3.0	30
Coorg	3.8	0.2	9
Total	2,298.9	105.0	1,985

Assuming that at present roughly 10 million tons of rice are processed by rice mills out of a total annual production of 27 million tons in the whole country, an additionl number of nearly 40 lakhs of persons can be provided with employment if this entire production of the rice mills could be taken over by the handpounding industry, on the basis of 150 days in the year available for each person for this subsidiary work. Even at the rate of 12 annas per head per day, the total wages earned, in a year of 150 days by this labour population would be about 45 crores of Rupees. This shows the great potentiality that the hand-pounding industry has as a means of employment to the large under-employed rural population. The handpounding industry is particularly suitable as a subsidiary occupation to women workers and until recently, when it was pushed out from some of the States by rice mills, it formed a traditional part-time occupation for our village women and hand-pounding implements are still to be found in many of the homes all over the country and can be made locally at a negligible cost.

It is chiefly competition by the mills that has put out the hand pounding industry. For every mill that was introduced, about 500 persons were thrown out of handpounding work. Even the small huller machine which has been and is rapidaly expanding in number and has invaded the villages, displaces about 40 persons employed in hand-pounding. As has been observed, the tendency is still for the mills and for the small huller machines to expand their activities to the further detriment of the handpounding industry. Unless this increasing competition from the mills is checked, it will be difficult to encourage and develop handpounding.

5

Small Huller Machines

Of the mills, the most serious menace to the handpounding industry is the small huller machine which operates in the village in front of the labourers' homes. These small huller machines do not serve any useful purpose. On the other hand, they are wasteful and difficult to control. They are wasteful because, unlike bigger rice mills,—especially sheller rice mills—they are handled by unskilled labour causing more brokens, less recovery of rice and produce a mixture of broken husks with the bran; thereby reducing the value of the bran as cattle feed. It is difficult for any administrative machinery to control or supervise these machines, because they are scattered all over the villages. They are instrumental in depriving the agricultural workers who used to make a living by handpounding of their means of livlihood, because large producers find it cheaper to get their paddy milled by these small machines instead of having it handpounded. The small hullers have increased in number also as a result of rural electrification and are often used with irrigation pumps provided by the Government to cultivators on loan basis. The huller, excluding the motor, costs little, about

Rs. 200, and the motor or the oil engine can be used for various other purposes. The Committee considers that rice-milling by means of small huller machi- nes should be banned as soon as possible. These machines were, during the days of control, required to take out licences under the old Rice Mills Control, Orders. It is proposed that these should be brought under a licensing system in terms of fresh Rice Mills Control Orders to be issued for these machines and the licences of exsiting machines should not be renewed. This would eliminate these hul-lers within about a year. The Committee suggested 31st December 1956, beyond which date no such machine should be allowed to operate. Such a measure will be justified on ground of law and equity, because, as already pointed out, these small hullers caused wastage of food in the process of milling and it will be against public interest to allow such wastage, and because they aggravate the unemployment problem in the rural areas by throwing out larger and larger number of persons from the handpounding indu-ustry.

Big Rice Mills

The abolition of small huller machines, as suggested above will afford the handpounding industry scope for its speedy revi-val in the villages, but its development even in the villages could be thwarted by new rice mills being set up to take over the small huller machine.

There is practically unanimity of opinion that no more rice mills should be allowed in the country as the number of existing rice mills is quite enough for meeting all the essential needs, and in some areas there are more than enough and new rice mills will serve no special purpose; but will only throw more people out of the handpounding industry. The Committee entirely agrees with this view and recommends its acceptance with immediate effect as the Government's policy.

To enforce this recommendation, the system of licensing rice mills should be introduced in all the States. During the days of control, all rice mills were subjected to a licensing system by Rice Mills Control Orders issued by State Governments under the Central Essential Supplies (Temporary Powers) Act 1944. This Central Act ceased to be in force in January 1955 and has since been replaced by a new Act, viz., The Essential Commodities Act, 1955, which has given fresh powers to the State Governments to issue orders for the licensing and control of rice mills. Some State Governments who have not yet reintroduced the system of licensing rice mills by fresh orders, should be requested to do so immediately. In fact, this Committee, during its investigation, wrote to the Minitstry of Food and Agriculture to advise the States not to grant any new licence for rice mills pending receipt of the Committee's final recommendations. In connection with the licensing system to be introduced, it will be useful for the State Governments to have a complete census taken of all the existing rice mills in order to ensure that all of them take out licences.

6

Restriction of Production by Existing Mills

After decontrol, the tendency of the bigger mills of large capitalists has been to increase their production rapidly, thereby pushing out not only the handpounding industry, but also those mills which are not so large. The object of the proposal not to allow new mills will be defeated if the existing mills can expand their production or, in other words, if their production is not definitely restricted. Increase in production by a mill can be by adding to the existing installation and by increasing the number of working hours. Restriction in both these directions is necessary. The existing mills should not be allowed to have additional installations. Most of these mills did

not, in the past, work up to their full capacity. There is no justification now to allow them to work up their full capacity and thereby narrow down the field of the handpounding industry. The Committee, therefore, considers it necessary to restrict the production of these mills. In fact, the object should be to reduce their production gradually. To enforce such restriction by prescribing a quota for each mill would be difficult and would require an elaborate staff. A simpler and easier method would be to have a general limit on the hours of work of the rice mills so that the over-all production by mills may not increase. A check on this limit is easy especially in the case of mills driven by electricity, the supply of which should be controlled. The Committee recommends that their production should be restricted to not more than six hours a day. If, however, this is not considered effective enough to achieve the object in view, the Government may prescribe any other more suitable alternative, the chief idea being that the production by each mill should not increase, but should progressively decrease.

7

Summary of Recommendations

The Committee's recommendations based on the conclusions reached by it are given below :

1. Licensing of all types of power driven rice mills, and recognised hand-pounding centres organised as co-operative societies or by recognised institutions and social workers or by the trade engaged in producing hand-pounded rice working on factory scale, should be immediately introduced in all States under the Essential Commodities Act, 1955, where this has not already been done under a State Act. A census should be taken by the State Governments of all existing rice mills.

2. No licences for new rice mills or rice milling in combined mills should be granted. If, however, a new mill is considered by the local Government to be absolutely essential in the public interest, in special circumstances, for example, in emergencies, the licence should be given to the required number of the smallest unit managed either by the Government or by Co-operative Societies as Government may decide. The decision in this matter should be taken in each case at State Government level.

3. No additional capacity to any of the existing rice mills should be allowed.

4. No rice mill should be permitted to work for more than six hours a day, the object being that the existing over-all production of the rice mills should only be not increased, but should be decreased.

5. Immediate action should be taken to eliminate small huller machines which operate with one or two hullers. Similarly rice hullers working in combination such as pumping out or lifting water for agricultural or other purposes should be prohibited. In no case should the licence of any such small huller machine be renewed to work after 31st December 1956 and the Government should take suitable steps, where necessary, for example, in the case of displaced persons, for rehabilitating owners of husking machines in some alternative employment.

6. A cess @ 0-6-0 per maund of paddy milled should be imposed on all rice mills and the proceeds of the cess should be utilised for organising the handpounding industry, for research to improve handpounding implements and for a subsidy to hand-pouned rice. Necessary legislation should be enacted for the imposition of cess on rice mills.

7. The existing average subsidy of 0-6-0 per maund of paddy handpounded should be increased to 0-8-0 per maund of

paddy. The subsidy should be granted through recognised handpounding centres organised as co-operative societies or by recognised institutions and social workers (wherever the price of the handpounded rice is higher than milled rice). The subsidy should be for a specified period of, say, five years, after which the position should be reviewed by the Government.

Individuals engaged in producing handpouded rice certified by the All India Khadi and Village Industries Commission may be allowed concessions in the form of easy credit and implements at subsidised rates.

8. The handpounded rice produced at hand-pounding centres certified by the All India Khadi and Village Industries Commssion should be exempted from sales tax, in States where rice is subjected to sales tax. The existing rules should be amended accordingly.

9. State Governments should purchase only handpounded rice preferably from Government subsidised handpounding centres where they exist for their requirements for jails, Government hospitals, the railways, the army, the police, etc. Government should issue a directive to all Government aided and controlled concerns, institutions and canteens (such as Railway canteens) to purchase only handpounded rice, preferably from Government subsidised handpounding centres where they exist.

10. Each State Government should immediately formulate a programme for the speedy organization of hand-pounding for home consumption and at centres for sale, so as to cover within the shortest possible time and milling capacity released by the proposed closure of small huller machines, in order that the supply position of rice is ensured.

Handpounding Industry should be further organised in other areas also for improving the employment position and for producing the supplies required in those areas so as to replace

production by the rice mills. Each State Government should draw a five year phased programme on the lines indicated in this report, for the speedy organisation and development of the handpounding industry, with a view to the employment of the maximum number possible of the unemployed or under-employed rural labour, and for the elimination of rice mills in the States within that period, regard being had to the maintenance of normal supplies of rice to the community. Each State Government should review this five year plan every year and revise it with reference to the progress achieved in the previous years and the target to be achieved.

11. The programme of State Governments for speedy organisation of the hand-pounding industry should proceed on a co-operative basis and should follow the recommendations made by the Reserve Bank of India in their Rural Credit Survey Report regarding co-operative processing and marketing of village produce. At the end of 3 years there should be a review by the Government of India of the progress made by each State in the implementation of these recommendations, so far as hand-pounding of rice is concerned.

12. All State Governments, by issuing orders in exercise of powers conferred on them by the Essential Commodities Act 1955, should restrict the milling of rice by rice mills to five per cent with a minimum milling of three per cent.

13. Exemption from the restrictiou under item (12) should be granted for rice produced for the export market in which case the milling should be adjusted to the requirements of the purchasing country. Such production should be with the special permission of the Government of India and under their close supervision.

14. In the case of any import of rice, the rice of the standard of milling as stated above, should be imported as far as possible.

15 Any rice mills which may be retained to meet essential

needs, for production for export, or for any other reason should be only of the sheller type or of the combined sheller-huller type.

16. The Essential Commodities Act 1955, and if necessary, the Constitution, should be suitably amended to enable the State Governments (1) to issue orders under items (2) to (6) with the oubject of creating work for the rural unemployed, (ii) to restrict milling by rice mills (item 12) with the object of retaining the nutritive value of milled rice, and (iii) to convert any huller mills or combined sheller–huller mills.

17. Publicity and propagands should be made through schools, colleges, the Community Development and National Extension Blocks, Women's organisations, the Red Cross, the Cinema, the Radio, the Stage and Literature :

i. to emphasize the nutritive value of under–milled rice and handpounded rice and induce consumers to eat handpound rice ;

ii. to emphasize the greater potentiality of the handpounding industry to provide employment ;

iii. to discourage the present practice of washing and cooking rice by which its nutritive value is lost and to propagate the correct method for retaining it in cooked rice.

18. Research should be conducted for evolving simpler and better hand-pounding implements with a view to increasing their output and at the same time making them easier to handle,

19. Each State Government should have a special agency under its Co-operative Department to orgainse co-operative societies as suggested in their recommendations.

20. The Central Government should appoint a special agency to act as liaison between them and the State Government with a view to the enforcement of the Government of India's policy in these matters.

CHAPTER IX

THE BOARD'S PROGRAMME

From the pervious Chapters it must be evident that rice is the most important cereal in India and that it accounts for 35.8 per cent of the area under cereals and 44.6 per cent of their total output; that it is the stapl diet of over 70 per cent of the population of India; and that, consequently, any measure that improves that quality of rice or augments its availability is of vital economic and nutritional importance. The development of the handpounding industry in India had, therefore, a three-fold significance:

i. it can provide employment on a large scale, particularly, to the women in the rural areas for 150 days in a year on an average;

ii. it can augment the availability of rice by higher percentage of recovery from paddy, and

iii. it can supply rice which is rich in food values and thus cotribute to the improvement of the health of the population.

The Planning Commission recommended in its first report:

(a) a progressive reduction in the number and scale of operations of the huller type of mills with a view to their ultimate elimination; and

(b) organized assistance to develop handpounding of rice in the country.

1

The Board has a Plan

In the light of these recommendations and the growing need for a national policy in this regard, the All India Khadi and Village Industries Board recommended to the Government of India in May 1953 to assume powers through suitable legislation

(a) to ban the establishment of additional huller type rice mills; and

(b) to prevent the expansion of the capacity of production of existing sheller type of rice mills.

The Government of India appointed the Rice Milling Committee to examine the question from all aspects and points of view and make recommendations. The findings of the Committee completely endorsed the view of the Board, which prepared a Five-Year programme in the light of the recommendations of the Committee. The programme envisaged the transference of all the paddy processed by the mills, estimated at 15 million tons, to the handpounding sector, phased over a five-year period, as shown in the table below :

Allocation of Production

(Lakh tons)

	1956-57	1957-58	1958-59	1959-60	1960-61
1. Mills	100	80	50	20	1
2. Handpounding	50	70	100	130	149

The phased allocation of production took into account the production of handpounded rice on traditional implements by independent or co-operative handpounders who, as a result of the programme, may have better operative conditions. The figures of production during the last three years of the Plan shown in the

Table above represent the progressive replacement of existing tools and implements by improved tools.

The policy implications of this allocation of production are :

1. the gradual elimination of mills over a five-year period ;
2. phased transfer of paddy processed by the mills to the handpounding industry ;
3. imposition of a cess on the paddy processed by the mills at the rate of 6 as. per md ;
4. the grant of a production subsidy to handpounders at 8 as. per md. of paddy ; and
5. provision of organised assistance to handpounders to secure improved implements.

The programme provided for the

1. the manufacture and distribution of 1,70,000 chakki-dhenki units, 8 lakh improved (Assam) dhenkis and 10,000 winnowing fans over the plan period ;
2. the establishment of 1,500 marketing depots (500 in the cities and 1,000 in the towns) to ensure the regular supply of handpounded rice to urban areas;
3. provision of training facilities for 900 persons to organise production, 2,000 mistries to manufacture chakkis, dhenkis and other implements, and 300 nutritional guides to carry on house to house propaganda; and
4. the constitution of 300 nutrition committees in selected urban areas mainly to popularise consumption of handpounded rice.

The main production unit is a Chakki-dhenki unit capable of processing on an average 43 tons of paddy in the season and

providing employment to six persons on an average. These units are to be introduced in areas where groups of handpounders can easily come together for work. A unit consists of one chakki, employing two persons, with an average capacity to dehusk 8 to 10 maunds of paddy and two dhenkis for milling, employing two persons each having an average milling capacity of 4 to 5 maunds per day. The phased introduction of improved implements, on the one hand, and the provision of organizational financial and technical assistance, on the other, the Board believed, will help to take over the handpounding of rice and provide, in the process, additional employment to 26.20 lakhs persons and distribute Rs. 184.10 crores as wages over the Plan period. The introduction of improved implements as envisaged by the programme involved a total capital outlay of Rs. 5.36 crores. Besides, it was proposed to subsidize the distribution of these implements upto 75 per cent of their cost and cover the balance by loans. In other words, of the total expenditure of Rs.5.36 crores on the improved implements, Rs. 1.34 crores are loans and 4.02 crores equipment subsidy.

The main objective of the programme is to transfer the entire quantity of paddy processed by the mills to hand-pounding. There is, thus, urgent deed to narrow the differences in the prices of handpounded and mill processed rice, estimated by the Rice Milling Committee at Rs. 1-4-0 per md. on an average. While the payment of a subsidy at Rs. 1-4-0 per md. to cover the entire price difference may impose a serious financial burden on the Government, the Board's programme proposed a production subsidy at 8 as. per md. of paddy handpounded, and the imposition of a cess on mill production at 6 as. per md. of paddy. The production subsidy will be paid only to those handpounders who come under the cooperatives, or registered institutons or certified social workers, and not to all the existing handpounders. As the quota transferred to the handpounding industry increases, the need for continued payment of subsidy may not

be as urgent as in the initial two years, during which the entire organizational work has to be completed. The expenditure by way of production subsidy estimated at Rs. 23.45 crores is based on the assumption that production subsidy may have to be paid in full during the first two years and in the third year on the quota of 10 million tons transferred during that year from the mills; and in the fourth and last years of the Plan, there may be no need to pay subsidy, as handpounders may have taken over the bulk of domestic output of paddy.

As against the requirements of production subsidy, estimated at Rs. 23.45 crores, the proceeds from the proposed cess is estimated at Rs. 25.31 crores. Thus the imposition of the cess may yield the necessary funds to provide appropriate incentives to increase the production of handpounded rice.

To ensure regular supply of handpounded rice to urban areas, the programme proposed to set up 1,500 sales depots in two years. To encourage cooperative or registered institutions or social workers to undertake this work, it was proposed to pay a subsidy to cover their establishment charges. As these depots are expected to become self-supporting over a three-year period, these subsidies will be progressively reduced from Rs. 2,500 per depot in the first year, to Rs. 1,500 and 1,000 in the second and third years of the Plan. The total expenditure on grants-in-aid would be about Rs.50.0 lakhs over a five-year period.

The Nutrition Committee would carry out intensive local propaganda to influence consumer demand and otherwise popularize handpounded rice. To cover their expenses the programme provided for Rs. 2,000 per committee per year, or Rs. 18.0 lakhs over the five-year period.

To undertake the handpounding of rice in accordance with the annual quotas envisaged by the programme, it may be necessary to assist cooperatives, registered institutions and others with

adequate funds to carry stocks of paddy. The programme provided for Rs. 10 crores. This volume of loans may not, however, be necessary, if warehouses, as recommended by the Rural Credit Survey, are established.

To provide 209 technically trained executive personnel, field organisers, supervisors and their assistants, and to train 300 nutrition guides and mistries and artisans required to manufacture the required implements, the programme provided for an expenditure of Rs. 1.12 lakhs. To coordinate the activities all over the country, on the one hand, and to organise the programme for training, manufacture of implements and provision of financial assistance and also undertake publicity and propaganda so necessary for the popularisation of handpounded rice, on the other, the programme provided for a central organisation and corresponding organisation in the States involving a total expenditure of Rs. 278.14 lakhs.

The total financial requirements of the development programme for the handpounding industry, according to the Board's proposals, were Rs. 42.44 crores, of which Rs. 31.10 crores represented expenditure and Rs. 11.34 crores loans. The net requirements of the programme are, however, Rs. 17.13 crores if the proceeds from the cess on mill production are taken into account.

2

Karve Committee's Report

The programme was examined by the Village and Small Scale Industries (Karve) Committee appointed by the Planning Commission in the third quarter of 1955. The Committee agreed with the views of the Board in all fundamentals, but did not accept the proposal for the imposition of a cess on rice mills. The alternative suggested is an excise duty which will reduce the competetive power of the rice mills. Another point on which

the Committee has differed from the Board's proposals is on providing for a production subsidy. The Committee does not endorse the view that this subsidy should be given uniformly in all areas. The need for it is recognised in areas where competition from mills is acute. The Committee, dealing with this industry, said:

"We consider that handpounding of rice should be treated as an integral part of village economy for the purpose of meeting domestic and local demand. Factors which operate to dislodge it from this position should be resisted and counteracted. At the same time we think that, in particular areas and for particular purposes, processing of paddy in the mills will be necessary as long as the alternative is not available. We, therefore, recommend that new sheller or combined sheller–huller mills or huller mills or single hullers should not be allowed to be set up and no increase in production above the present level should be permitted during the plan period, except when handpounding cannot be organised; for example, when production in an area where labour is scarce has to be augmented quickly or supply to a new industrial area has to be arranged. In such cases, the mills allowed to be set up should be owned wherever possible by cooperative societies or by Government.

These measures will not result in transfer of paddy which is already being processed by the mills or hullers to handpounding, but they will ensure that the increased production of paddy of 6.6 million tons is processed almost entirely by hand-pounding equipment.

We consider that the handpounding equipment can and should be greatly improved in technical efficiency. We are informed that the improved Assam dhenki can produce as much as 5 maunds per day of 8 hours as against 1 to $1\frac{1}{2}$ maunds by ordinary dhenki. We have no doubt that, by constant research, even better type

of equipment can be devised and we would emphasise that all schemes for the manufacture and introduction of improved hand-pounding equipment such as chakki–dhenki units, improved (Assam) dhenkis and winnowing fans and for the organised marketing, handpouded rice should be given all possible encouragement and assistance. It should be ensured that such assistance is extended through cooperative agencies.

Measures for preventing establishment of new sheller and huller mills and single hullers and limiting their production to existing levels which we have recommended, will have the effect of placing the existing mills in a position of advantage. We consider that there would be justification for levying an excise duty on all hullers and shellers, huller or combined huller-sheller mills. We therefore, recommend that an excise duty at an appropriate rate should be levied on all these to offset the advantage which would accrue to them as a result of the ban on the establishment of new mills. The proceeds of the excise duty will be available for being utilised for the improved equipment and better organisation of the handpounding industry.

The excise duty may offset substantially the differential advantage enjoyed by rice mills and, together with the measures of positive assistance recommended by us, would enable the handpounding industry to withstand the competition of mills. However, it may be necessary, in the initial stages, to give, where competition is keen, extra assistance in the form of a temporary production subsidy to cooperative societies or to approved registered institutions composed of handpounders to induce and assist the change over to improved methods.

In making the above recommendations we have taken into account the production and employment aspects of rice milling. The higher nutritive value of under-milled rice is admitted by nutritional experts. In what manner the advantages in respect of nutrition can be obtained through regulation of the rice mills

and their processing operations is a matter for Government to decide.

Total expenditure on developing and improving the hand-pounding industry with a view to the hand-pounding of the entire increased production of rice, over the plan period is estimated at Rs. 8.25 crores—Rs. 25 lakhs at the centre and Rs. 800 lakhs in the States. For working out State-wise allocations the annual average of rice production in the States in 1953-54 and 1954-55 has been adopted as the basis. It is estimated that additional seasonal employment will be provided to about 1 million persons engaged in the hand-pounding of rice".

3

The Revised Plan

In the light of the Karve Committee's report the All India Khadi and Village Industries Board submitted a revised plan to the Planning Commission. The revised plan for the hand-pouding of rice industry, however, is fundamentally the same as the one described above. The departure made is in respect of the size of the programme and its various components. The programme aims at directly organising the processing of only 4 million out of the 6.6 million tons of paddy allotted by the Karve Committee. Towards this end, the programme envisages the manufacture and distribution of 43,000 chakki-dhenki units, 1,45,000 improved (Assam) dhenkis and 1,500 winnowing fans over the plan period.

The productive capacity of the improved implements to be introduced during the plan period will rise to 5.13 million tons by 1960-61. As those units are not, however, likely to utilise fully their respective productive capacity and on the assumption that chakki-dhenki units, which are mainly meant for com-

mercial production, work upto 75 per cent and dhenkis upto 80 per cent of their respective productive capacities, the actual annual production by 1960-61 may reach the desired target of 4 million tons.

The implementation of the revised development programme will provide seasonal employment to 5.78 lakh persons and distribute Rs. 28.06 crores as wages over the plan period. The size and productivity of the various production units as well as estimates of employment are the same as in the Board's earlier proposals.

The implementation of the programme requires trained personnel to organise production of improved implements and supervise their distribution among the various production units in different areas of the country. The programme, therefore, provides for one Central Training Institute and 20 State Training Classes charged with the task of training 600 supervisory personnel by the end of the 3rd year and 1000 mistries by the end of the first year itself. Supervisory personnel as well as nutrition guides will be trained at the Central Institute and mistries at the State Training Classes. The training programme may involve a total expenditure of Rs. 4.07 lakhs over the plan period.

The popularisation of hand-pounded rice and the organisation for its regular supply to urban areas constitute important parts of the programme. Over the Plan period the programme provides for the constitution of 200 Nutrition Committees which will be subsidized during the first 3 years to carry on intensive propaganda through trained nutritional guides and the organisation of 200 city and 300 town depots to which subsidies will be paid to cover initial expenditure on various types of equipment and storage facilities. The expenditure on marketing and propaganda may amount to Rs. 32 lakhs over the plan period.

The Karve Committee recognised the need to develop the hand processing of rice to meet domestic and local demand and recommended the imposition of an excise on the output of the mills and the payment of a subsidy to handpounders to reduce the price differential between hand processed and mill processed rice. Of the commercial production of 3.75 million tons of hand -processed rice through the chakki-dhenki units, only a part may become eligible for subsidy as subsidy can be paid through only cooperative and/or registered or recognised institutions. Consequently, the programme estimates that not more than a certain percentage of the annual production by chakki-dhenki units may become eligible for subsidy. With the availability of trained personnel and improved implements, the number of cooperative and/or registered or recognised institutions undertaking the supply of hand-pounded rice to urban areas may increase as the plan progresses. On these assumptions, the total volume of hand-processed rice that may become eligible for subsidy, is estimated at about 1.83 million tons. The Board considers the payment of production subsidy at As. 6 per Bengal maund of paddy as the barest minimum. At this rate, production subsidy on 1.83 million tons amounts to Rs. 1·97 crores.

The revised development programme of the hand-pounding of rice industry involves a total outlay of Rs. 1.17 crores over the plan period, of which Rs. 88.03 lakhs are subsidies and Rs. 29.37 lakhs recoverable loans. These estimates are based on the Board's earlier proposals.

Besides the expenditure on the various items of development detailed above, there is need for working capital for undertaking the operations envisaged above. As the establishment of the proposed Warehousing Corporation may take time, working capital is estimated at the rate of 1/3 of the total value of paddy processed by the cooperative and/or registered or recognised institutions that may be set up to organise the commercial

supply of hand processed rice. Should institutional credit become available to the cooperatives, requirements of loans may be substantially smaller than estimated, namely, Rs. 9.29 crores. During the first 2 or 3 years of the plan period direct loans for working capital are, however, indispensable for the progress of the industry.

The functions of the Central and States organisations are the same as in the Board's earlier proposals. Expenditure on organisation has, however, been revised to accord with the smaller development programme. Eexpenditure on organisational machinery at the Centre and in the States is estimated at Rs. 114.6 lakhs, of which Rs. 17.78 lakhs are expenditure at the Centre and Rs 126.8 lakhs expenditure in the States.

The revised development programe for hand-pounding of rice industry, thus, involves a total development expenditure of Rs. 4.98 crores. This development programme will provide seasonal employment to 5.78 lakh persons and distribute Rs. 28.06 crores as wages, and account for a total processing of 100 lakh tons of paddy to produce hand-processed rice valued at Rs. 530.26 crores over the plan period.

4

In the Second Five Year Plan

The revised programme of the Board for the development of the handpounding industry presented in the paragraphs above, was submitted to the Planning Commission. The Second Five Year Plan, however, has departed from the specific postulations of the First Plan, especially in regard to the emphasis on the elimination of huller type rice mills and policy requirements

of a common production programme. The criterion that is applied to a State policy of protection from competition from the large-scale proto-type of village industries, is now stated as follows :

"Proposals for non-expansion of the capacity of a large-scale industry have to be considered from two different points of view. The first is the extent to which such a measure would enlarge the market for small units. It may sometimes be that for lack of organisation or other similar reasons full advantage may not be taken of the available market. The second aspect to consider is the volume of production of a commodity that may be required in the economy. In this connection, the likely trends of future demand are specially relevant during a period of development in which considerable public and private outlay will occur. Within the limits set by the need to avoid shortage of goods, on the one hand, and the extent to which production in small units can be organised effectively to take advantage of a larger market in any individual case, on the other, the balance of public advantage will determine whether and at what level the capacity of a large-scale industry should be limited. In applying the policy there is need for review from time to time in the light of changing economic conditions."

The Second Five Year Plan refers to the development programme for the handpounding industry in the following terms :

"Problems of development of this industry have been recently reviewed by a special committee known as the Rice Milling Committee. The Village and Small-Scale Industries Committee also made recommendations regarding the programme for this industry. Taking these into consideration, it is proposed that all power-driven rice mills should be licensed and that no new mills should be allowed to be set up nor expansion of capacity of the existing mills allowed, except where it is considered absolutely essential in the public interest in special circumstances. The

question of elimination of hullers can be reviewed later in the light of the employment situation. It is recommended that the existing subsidy paid at the average rate of 6 annas per maund of handpounded paddy should be continued and that hand-pounded rice produced by hand-pounding centres and certified by the Khadi Board might be exempted from sales tax. The level of technical efficiency and output of the hand-pounding equipment will be raised by implementing schemes for manufacture and distribution of chakki-dhenki units, improved (Assam) dhekis and winnowing fans. To ensure regular supply of hand-pounded rice to urban areas, marketing depots will be established and steps will be taken to popularise the consumption of hand-pounded rice".

The position taken up by the plan, it is unfortunate, is halting and does not provide the appropriate incentive to a quick revival of the hand-pounding industry. The penetration of the small hullers into rural areas has already done considerable damage to this home industry. The implied permission to work the existing mills to their full installed capacity is likely to adversely affect the flow of the additional paddy production to the hand-pounding industry. Thus, in the formulation of its programme, the Planning Commission has failed to appreciate at its proper value the importance of hand-pounded rice in the maintenance of nutritional standards for the main article of food of a majority of the population and of the needs of national health.

CHAPTER X

SOME PRACTICAL SUGGESTIONS

We have considered the food value of rice, and seen how by machine-milling and polishing, this staple food of a large percentage of our people, is not only deprived of much of its nutritive value, but is also rendered injurious to the human system. We may now bring together suggestions which may be made for ensuring that the rice-eater obtains the utmost from the rice which he consumes.

1. Washing & Cooking :

We haye already pointed out that much of the vitamins and minerai salts of rice are lost in washing and in faulty methods of cooking, where excessive water is used and thrown away. The easiest way of raising the nutritive value of rice is not to wash the rice much before cooking, and to cook in just enouah water, so that no water is left to be thrown away. Even if some rice water is left from cooking, it should be used in preparing curries and vegetables, and by no means discarded.

2. Parboiling :

We have also noted the good effect of parboiling. If polished rice must be eaten, it should be first parboiled and then polished ; for parboiled rice, even when highly milled, retains much of its food value. If people will not at once change over to

the use of merely dehusked or wholly unpolished rice, it is necessary to induce them to take to parboiled rice being the second best. Further, rice just harvested can be immediately consumed if it is parboiled, whereas raw rice has to be kept for a few months before it is fit to be consumed. This gives an additional advantage to parboiled rice.

The process followed in some of the big rice mills is too elaborate and cannot be imitated by the villagers. The ordinary village process of parboiling with pots, either earthen or metal, is too tedious and slow. So it becomes necessary to take advantage of a method where sufficient quantity of paddy can be handled in a comparatively short time with ease.

The equipment needed is an iron tank, cylindrical in shape, about 4 feet in diameter, and 4 feet in height. The bottom and sides are well rivetted or welded. For the top there should be a removable lid with handle attached to it. At a height of about 8 inches from the bottom, fix some clamps in the inside of the tank. On these clamps the false bottom rests.

There should be a small outlet on the side of the tank to let out the paddy when parboiled. False bottom is used to hold the soaked paddy in the tank, just a little above the surface of the water. The steam issued by the boiling water should penetrate into the heap of paddy above, and hence the flase bottom should be full of small meshes that will not allow the paddy to pass through. Strong wire mesh can be made with tight iron bands on the circumference. Also a thick plate of iron can be perforated for the purpose.

How to use the tank ? The tank should be fixed on to a permanent underground oven. Fill the tank with water up to the

level where the false bottom is fitted. Above the preforated false bottom fill soaked paddy. Cover the lid. Ignite the fire.

Now the water boils and issues steam which, in turn, parboils the paddy above. After the charge is over, open the small outlet on the sides of the tank and completely bring out all the parboiled paddy. Now fill in a second charge. This time it will be parboiled quicker than before. On the average each charge will take about 40 minutes. Generally about 15 maunds can be parboiled every time.

3. Composition and use of rice bran

The following extracts from 'Rice', Health Bulletin No. 28, published by the Manager of Publications, Delhi, 1940 give useful information in this regard :

The embaryo or germ area and the thin coating of the husked grain are collectively called bran and constitute the rice polishings which should be eaten if rice is consumed in the polished state. Bran has the following valuable ingredients :

	Per cent
1. Calcium, iron, phosphorus etc.	8.7
2. Proteins	19
3. Fat	20
4. Vitamin B_1, B^2, and E	

As 11 parts of unpolished rice yield about 10 parts of polished rice and 1 part of polishings, bran must be consumed in the ratio of 1 to 10 of polished rice.

It should be eaten while it is fresh. It can be stored for about a week if it is slightly roasted over fire..

It can be made into biscuits, or ground fine and with 15% gur (jaggery) and 5% coconut scrapings, kneaded and baked on an iron pan as a thick chappati, fried in oil in mall cakes or steamed and eaten as a pudding. It makes a good addition to wheat or ragi porridge when it is sprinkled on the porridge and eaten with it. It can be mixed with the dough (30%) while making chappatis or puries. It may also be used in curries or made into sweets.

4. Consuming Coarse Rice

Coloured and so called coarse varieties of rice, discarded by the well-to-do because of their appearance, are generelly richer in nutritive value than the white and fine varieties, which command a high price in the market. They contain large quantities of proteins and minerals, particularly phosphorus, calcium and iron, and not inferior to wheat in nutritive value. Further, the coarse type possesses thicker bran layers, so that the loss of bran and bran constituents through miliing is less in the case of coloured and coarse varieties as compared with the loss sustained by the so called superior varieties. It is, necessary, therefore to educate people to consume the coarser rice.

5. Milling :

We have seen how machine-milling very seriously reduced the nutritive value of rice, more especially of raw rice. As in some parts of the country only raw rice is consumed, it is necessary to carry on vigorous propaganda against having the paddy taken to mills for husking and polishing. People should be induced to husk the paddy in small quantities in the home on the chakki as this leaves the rice entirely unpolished. If slightly polished rice is desired, it may be pounded in a dhenki.

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